

ПЕРМСКИЙ
ГОСУДАРСТВЕННЫЙ
НАЦИОНАЛЬНЫЙ
ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ

АКАДЕМИЧЕСКАЯ
И ПРОФЕССИОНАЛЬНАЯ
КОММУНИКАЦИЯ
НА ИНОСТРАННОМ ЯЗЫКЕ

Materials for Natural Science Studies:
Chemistry in Focus



МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ
РОССИЙСКОЙ ФЕДЕРАЦИИ

Федеральное государственное автономное
образовательное учреждение высшего образования
«ПЕРМСКИЙ ГОСУДАРСТВЕННЫЙ
НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ»

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Учебное пособие направлено на развитие у студентов способности использовать иностранный язык в профессиональной сфере посредством изучения терминологии предметной области и развития терминологической грамотности.

Издание предназначено для студентов очного отделения магистратуры химического факультета, обучающихся по направлению 04.04.01 «Химия», и является дополнением к основной учебной литературе.

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Введение

Предлагаемое учебное пособие предназначено для формирования иноязычной терминологической компетенции магистрантов химического факультета в курсе обучения английскому языку для академических и профессиональных целей (English for Academic and Scientific Purposes) и может быть использовано как на занятиях в аудитории, так и при организации самостоятельной работы студентов. Издание является продолжением серии учебных пособий, начатой Е. В. Исаевой¹ и основано на материалах, полученных в ходе коллективного проекта по созданию англо-русского толкового словаря терминов в «облачной» среде с применением Wiki-технологий. Проект реализуется сотрудниками кафедры английского языка профессиональной коммуникации Пермского государственного национального исследовательского университета в течение шести лет.

Под руководством преподавателя студенты выбирают серию научных, научно-популярных статей или монографию по изучаемой специальности. При чтении и переводе статьи магистранты выделяют и отмечают в текстах термины, которые затем вносят в словарь. Для каждого термина формируется словарная статья, состоящая из эквивалента на русском языке, дефиниции на английском языке, контекста употребления выбранного термина (3-5 предложений из статьи). Описание термина дополняется указанием части речи и категории понятий, к которой принадлежит термин. Студенты, ранее участвовавшие в проекте, предложили категории, соотносящиеся с разделами химии. Именно эти категории задают структуру настоящего учебного пособия и отражены в содержании².

В табличной форме словарная статья выглядит следующим образом:

Термин	plating
Часть речи	noun
Категория	Physical Chemistry, Materials Science
Перевод	нанесение покрытия электролитическим методом

¹ Исаева Е.В. **Академическая** и профессиональная коммуникация на иностранном языке. Осваиваем терминологию направления «Прикладные математика и физика»: [Электронный ресурс]: практикум: учеб. пособие / сост. Е. В. Исаева, К. С. Рушинская; Перм. гос. нац. исслед. ун-т. – Электрон. дан. – Пермь, 2018. – Режим доступа: <https://elis.psu.ru/ident/978-5-7944-3107-0>; **Терминологический** инжиниринг на иностранном языке. Осваиваем терминологию компьютерной безопасности [Электронный ресурс]: учебное пособие / составители Е.В. Исаева, Е.М. Глушкова, А.Д. Иванов; Пермский государственный национальный исследовательский университет. – Электронные данные – Пермь, 2020. – Режим доступа: <http://www.psu.ru/files/docs/science/books/uchebnie-posobiya/isaeva-glushkova-ivanov-terminologicheskij-inzhiniring.pdf>.

² Более подробно о проекте и подготовке материалов для пособия можно узнать из работы: Байбурова О. В., Баранова И. А. Терминосистемы химической науки в лингводидактическом аспекте // Евразийский гуманитарный журнал. 2019. №S4 (2). Режим доступа: https://www.elibrary.ru/download/elibrary_42211105_32128884.pdf

Дефиниция	An act of making a thin coating of metal laid upon another metal or material (http://engood.ru/anglijskij-tolkovyj-slovar/).
Пример из текста	1. A commonly encountered defect is extraneous plating underneath the photoresist layer ('underplating) which is highly undesirable in most applications. 2. Poor control of the dimensional tolerances and distorted bump features have also been observed during plating from a cyanide bath. 3. The influence of the plating conditions on deposit stress has also been explored in a number of papers (https://link.springer.com/article/10.1007/BF03215566).

В учебном пособии предлагаются задания разного типа, направленные на введение термина, знакомство с его фонетической формой, переводом на русский язык, толкованием, использованием в микроконтекстах (от словосочетания до фрагмента текста).

Каждый раздел учебного пособия начинается и заканчивается текстом. Первый текст, составленный в стиле короткой энциклопедической справки, вводит в тему раздела, знакомит с базовыми терминологическими единицами, часть из которых далее отрабатывается в ходе выполнения упражнений. Во втором тексте обсуждается одно из исследований, выполненных в рамках заданного раздела химии. Этот текст относится к научно-популярному стилю речи и приводится с сайта www.sciencedaily.com. К текстам предлагается 2-3 задания на дополнительную работу с лексикой, и обсуждение содержания статьи. В конце каждого раздела (за исключением первого) магистрантам предлагается найти научный текст по интересующей их теме и письменно изложить его содержание по предложенному в Приложении плану.

Мы рекомендуем выполнить все задания первого раздела "General and Theoretical Chemistry" в аудитории, предполагая, что данная лексика необходима химику любого профиля. Остальные разделы могут выполняться в любой последовательности, например, преподаватель может определить список разделов, связанных со специализацией группы или магистрант может выбрать лишь те темы, которые связаны с его диссертационным исследованием.

Наш опыт применения отдельных частей учебного пособия подтвердил прочное усвоение отрабатываемых лексических единиц, свободное употребление последних в устной и письменной речи и при переводе научных текстов магистрантами химического факультета.

Unit 1. General and Theoretical Chemistry

1. Reading and discussion

- a) **Read the text and say what important topics of General and Theoretical Chemistry are mentioned by the authors. Do you consider General Chemistry and Theoretical Chemistry to be parts of the same field of Chemistry or two different branches? In what way are they related to all the other branches of Chemistry?**

General chemistry is the study of matter, energy, and the interactions between the two. The main topics in chemistry include acids and bases, atomic structure, the periodic table, chemical bonds, and chemical reactions. Acids, bases, and pH are concepts that apply to aqueous solutions (solutions in water). pH refers to the hydrogen ion concentration, or the ability of a species to donate/accept protons or electrons. Acids and bases reflect the relative availability of hydrogen ions or proton/electron donors or acceptors. Acid-base reactions are extremely important in living cells and industrial processes.

Atoms are composed of protons, neutrons, and electrons. Protons and neutrons form the nucleus of each atom, with electrons moving around this core. The study of atomic structure involves understanding the composition of atoms, isotopes, and ions. Atoms and molecules join together through ionic and covalent bonding. Related topics include electronegativity, oxidation numbers, and Lewis electron dot structure.

The periodic table is a systematic way of organizing chemical elements. The elements exhibit periodic properties that can be used to predict their characteristics, including the likelihood that they will form compounds and participate in chemical reactions.

Chemistry is a science that relies on experimentation, which often involves taking measurements and performing calculations based on those measurements. A chemist should be familiar with the units of measurement and various ways of converting between different units, balancing chemical equations and different factors affecting the rate and yield of chemical reactions. An important part of general chemistry is learning about different types of solutions and mixtures and how to calculate concentrations.

Electrochemistry is primarily concerned with oxidation-reduction reactions or redox reactions. These reactions produce ions and may be harnessed to produce electrodes and batteries. Electrochemistry is used to predict whether a reaction will occur and in which direction electrons will flow. Thermochemistry is the area of general chemistry that relates to thermodynamics. Thermochemistry involves the concepts of

entropy, enthalpy, Gibbs free energy, standard state conditions, and energy diagrams. It also includes the study of temperature, calorimetry, endothermic reactions, and exothermic reactions.

Theoretical chemistry is the discipline that uses quantum mechanics, classical mechanics, and statistical mechanics to explain the structures and dynamics of chemical systems and to correlate, understand, and predict their thermodynamic and kinetic properties. Modern theoretical chemistry may be roughly divided into the study of the chemical structure and the study of chemical dynamics. The former includes studies of (1) electronic structure, potential energy surfaces, and force fields; (2) vibrational-rotational motion; and (3) equilibrium properties of condensed-phase systems and macromolecules. Chemical dynamics includes (1) bimolecular kinetics and the collision theory of reactions and energy transfer; (2) unimolecular rate theory and metastable states; and (3) condensed-phase and macromolecular aspects of dynamics.

A critical issue crossing all boundaries is the interaction of matter and radiation. Spectroscopy experiments are used as both structural and dynamic probes and to initiate chemical processes (as in photochemistry and laser-induced chemistry), and such experiments must be understood theoretically. There are also many subfields of theoretical chemistry—for example, biomedical structure-activity relationships, the molecular theory of nuclear magnetic resonance spectra, and electron-molecule scattering—that fit into two or more of the areas listed.

Another source of overlap among the categories is that some of the techniques of theoretical chemistry are used in more than one area. For example, statistical mechanics includes the theory and the set of techniques used to relate macroscopic phenomena to properties at the atomic level, and it is used in all six subfields listed. Furthermore, the techniques of quantum mechanics and classical-mechanical approximations to quantum mechanics are used profitably in all six subfields as well. Condensed-phase phenomena are often treated with gas-phase theories in instances in which the effects of liquid-phase solvent or solid-state lattice are not expected to dominate. There are many specialized theories, models, and approximations as well.

Source links: <https://www.thoughtco.com/general-chemistry-topics-607571>
<http://www.chemistryexplained.com/Te-Va/Theoretical-Chemistry.html>

b) Read the text again and find at least 10 international words from the terminological system of Chemistry.

2. Match the terms (1-14), transcriptions (1-14) and translations (a-n).

1) atom	1. [ɪ'lektɹɒn]	a) мономер
2) beaker	2. ['mɒlɪkjʊ:l]	b) бюретка
3) burette	3. ['sʌblɪ'meɪʃn]	c) нейтрон
4) concentration	4. ['bi:kə]	d) изомерия
5) electron	5. [aɪ'sɒmə,rɪz(ə)m]	e) валентность
6) isomerism	6. ['prəʊtɒn]	f) атом
7) isotope	7. [bjʊ'ret]	g) электрон
8) molecule	8. ['nju:trɒn]	h) молекула
9) monomer	9. [ˌɒksɪ'deɪʃn]	i) сублимация
10) neutron	10. ['ætəm]	j) изотоп
11) oxidation	11. ['aɪsətəʊp]	k) мензурка, колба, пробирка
12) proton	12. ['veɪlənsɪ]	l) концентрация
13) sublimation	13. ['kɒns(ə)n'treɪʃn]	m) протон
14) valency	14. ['mɒnəmə]	n) окисление

3. For each definition (1-14) choose a suitable term from task 2 (1-14).

- 1) A reaction in which the atoms of an element lose electrons and the valence of the element increases.
- 2) The smallest particle of a specific element or compound that retains the chemical properties of that element or compound; two or more atoms held together by chemical bonds.
- 3) The abundance of a constituent divided by the total volume of a mixture.
- 4) The smallest component of an element having the chemical properties of the element.
- 5) A positively charged subatomic particle forming part of the nucleus of an atom and determining the atomic number of an element.
- 6) An elementary particle with 0 charge and mass about equal to a proton; enters into the structure of the atomic nucleus.
- 7) One of two or more atoms with the same atomic number but with different numbers of neutrons.
- 8) A change directly from the solid to the gaseous state without becoming liquid.

- 9) One of the fundamental subatomic particles, having a negative charge and about one-thousandth the mass of a hydrogen atom.
- 10) A molecule that may bind chemically to other molecules to form a polymer.
- 11) The relative power of replacing hydrogen or combining therewith possessed by different elements; the number of atomic bonds belonging to any element.
- 12) The phenomenon whereby certain chemical compounds have structures that are different although the compounds possess the same elemental composition.
- 13) A glass tube with fine gradations and a stopcock at the bottom, used in laboratory procedures for accurate fluid dispensing and titration.
- 14) A flat-bottomed vessel, with a lip, used as a laboratory container.

4. Complete the paragraphs using the terms from task 2. In some sentences, the plural form is required. In each paragraph, the same word is missing.

- 1) A _____ is an electrically neutral group of two or more atoms held together by chemical bonds. _____ are distinguished from ions by their lack of electrical charge. However, in quantum physics, organic chemistry, and biochemistry, the term _____ is often used less strictly, also being applied to polyatomic ions. In the kinetic theory of gases, the term _____ is often used for any gaseous particle regardless of its composition. According to this definition, noble gas atoms are considered _____ as they are monatomic _____.
- 2) Constitutional _____ in chemical compounds arises from differences in the nature or sequence of bonding. Linear polymer chains give rise to a constitutional _____ if they contain 'nonsymmetric' monomeric units such that arrangements with different mutual orientations can be distinguished (a sufficient condition for this is that the 'nonsymmetric' units have no two-fold rotation axes unless they are parallel to the polymer backbone). This type of structural _____ has been known to exist in vinyl polymers for almost 50 years and has been well studied; the terms 'head-to-tail' and 'head-to-head/tail-to-tail' are associated with it. For vinyl polymers, it has been learned that constitutional _____ is generally not controllable, since vinyl polymerization is almost always characterized by high regioselectivity, which forces nearly perfect head-to-tail arrangements of monomeric units.
- 3) Analysis of ethanol-displaced soil solutions composition shows that the use of fertilizers is accompanied by a significant increase in soil liquid phase _____, and Na and Cl appear in large amounts. Calcium _____ increases as a result of Ca displacement from the soil adsorbing complex by monovalent ions, predominantly by K, of fertilizers. Soil liming is accompanied by an insignificant increase of Ca in the soil solution.

- 4) _____ is the transition of a substance from the solid phase directly to the gas phase without passing through an intermediate liquid phase. The heat of _____ is a crucial parameter in deciding upon the applicability of _____ to a particular substance, or indeed on the possibility of separating two components in a mixture. The theory and mechanism of _____ are of less practical importance to analytical procedures than it is in some other specialized areas of chemical science. Knowledge of _____ characteristics can aid improvements in the stability of materials used at high temperatures or low pressures. For analytical purposes, it should be sufficient to recognize that rates of _____ depend upon the topology of the vaporizing surface (dislocations, atomic steps, and ledge _____) and upon any atomic rearrangement that occurs during the _____ process.
- 5) After _____ the mass gain data (normalized to the measured initial surface area of the tubes) was used to quantify the _____ rate constants of each alloy at each temperature. The determined _____ rates were then used to determine the activation energies for _____ of each specimen. Thermogravimetric analysis was used to collect mass gain data during isothermal _____ and the data was used to quantify the _____ rate constant and the activation energy of _____.
- 6) A _____ system is a liquid consisting of _____ which will polymerize into a solid. Suitable _____ have varying degrees of volatility, toxicity, and flammability. They do not mix with water. They are very low in viscosity and will soak into dry concrete, filling the cracks, much as water does. The most common _____ used for this purpose is methyl-methacrylate. _____ systems used for impregnation contain a catalyst or initiator plus the basic _____ (or combination of _____). They may also contain a cross-linking agent. When heated, the _____ join together, or polymerize, creating a tough, strong, durable plastic that greatly enhances some concrete properties.
- 7) Atomic _____ may be emitted from atoms as a result of a nuclear decay process referred to as internal conversion. In such a process an unstable nucleus decaying to a lower more stable state transmits its decay energy to an atomic _____, which is emitted from the atom with an energy corresponding to the nuclear decay energy less the binding energy of the _____ to the atom. Another source of atomic _____ radiation is the emission of Auger _____. Auger electrons may be emitted by radioactive atoms, which have _____ shell vacancies and undergo _____ energy-level transitions. Radioactive atoms that decay by _____ capture (EC) or internal-conversion (IC) decay processes leave vacancies in _____ shells.
- 8) The classical _____ are the Hempel _____ and the Winkler, Bunte, and Tutweiler _____ in various modified versions. The most widely used _____ are those employed in Orsat instruments. The _____ consists of a glass cylinder graduated up-

wards from 0 to 100 ml. The water jacket surrounding the _____ is generally sufficient to protect the _____ from temperature changes. The sample is measured and the gas transferred to the absorption solutions using a confining fluid located in the leveling vessel.

- 9) CVD of single metal _____ at a surface is the most straightforward method to grow nanoparticles under UHV conditions. When metal _____ that are less electronegativity (and thus less ionization energy) are close to nonmetallic _____ that are more electronegativity (hence more affinity), the former can easily release its valence electrons of the outermost layer to become a positive ion, while the latter quickly absorbs the electrons released by the former to become a negative ion. Metal _____ do not interfere with one another when seeking to enlarge solid nuclei the way polymer and glass molecules do in viscous melts.
- 10) A _____ is a hydrogen atom that has lost its single electron or a single unit of negative charge and therefore, it is positively charged. _____ measurements with solid-state nuclear track detectors have suddenly become an urgent need since the advent of laser acceleration and the latest advances in the study of laser inertial-confinement fusion.
- 11) Thermal _____ data can be obtained at reactors providing thermal _____ beams from tangential beam tubes facing the water moderator (either in the pool or tank) or so-called thermal columns. Few high flux reactors and spallation _____ sources are equipped with so-called _____ guides where _____ are efficiently transported over large distances by total reflection on a vacuum-matter interface. These _____ guides are slightly bent to prevent a direct view of the source. Only thermal and slower _____ can follow the curvature by total reflection while faster _____ and gamma rays go straight and are stopped in the shielding of the _____ guide.
- 12) A _____ is generally a cylindrical container with a flat bottom. _____ are available in a wide range of sizes, from one milliliter up to several liters. A _____ is distinguished from a flask by having straight rather than sloping sides. The exception to this definition is a slightly conical-sided _____ called a Philips _____. _____ are commonly made of glass, but can also be in metal (such as stainless steel or aluminum) or certain plastics (notably polythene, polypropylene, PTFE). A common use for polypropylene _____ is gamma spectral analysis of liquid and solid samples.
- 13) _____ are atoms of the same element that have different numbers of neutrons but the same number of protons and electrons. The difference in the number of neutrons between the various _____ of an element means that the various _____ have different masses. The superscript number to the left of the element abbreviation indicates the number of protons plus neutrons in the _____. For example, among

the hydrogen _____, deuterium (denoted as ^2H or D) has one neutron and one proton. This is approximately twice the mass of protium (^1H), whereas tritium (^3H) has approximately three times the mass of protium.

14) The _____ of metals can change as a response to lowering redox potentials. For example, the very toxic Cr(VI) can be rapidly reduced to the less toxic trivalent Cr(III). The very low redox potentials in permanently reduced floodplain soils and sediments often also affect the _____ and environmental fate of mercury (Hg). These conditions promote the reduction of Hg(II) to Hg(I) or Hg(0). Optical spectroscopy is unsuitable to detect the fraction of each _____, even though Eu^{2+} and Eu^{3+} have strongly different spectral characteristics. X-ray photoelectron spectroscopy is in principle ideally suited to make a distinction between _____.

5. Match the terms (1-16), transcriptions (1-16) and translations (a-p).

1. amount of substance	1) [ˌævəˈɡɑːdrəvˈkɒnstənt]	a) молекулярная орбиталь
2. atomic mass	2) [pɪ(ə)rɪˈɒdɪkˈlɔː]	b) метод валентных связей
3. atomic structure	3) [ˈmɒləˈmæs]	c) количество вещества
4. Avogadro constant	4) [kəvˈveɪəntˈbɒnd]	d) кристаллическая решётка
5. Buchner funnel	5) [ˈmæs,kɒnsəˈveɪfɪnˈlɔː]	e) ионная связь
6. chemical bond	6) [əˈmaʊntəvˈsɪbstəns]	f) магнитная мешалка
7. covalent bond	7) [ˈkɛmɪk(ə)lˈbɒnd]	g) атомная структура
8. crystal lattice	8) [məˈleɪkjuləˈɔːbɪt(ə)l]	h) окислительно-восстановительная реакция
9. ionic bond	9) [əˈtɒmɪkˈmæs]	i) число Авогадро
10. magnetic stirrer	10) [ˌpɪksɪˈdeɪfɪnrɪˈdɪkʃrɪˈæksɪn / (ˈrɪːdɒks)]	j) периодический закон
11. mass conservation law	11) [əˈtɒmɪkˈstrʌktʃə]	k) химическая связь
12. molar mass	12) [ˈveɪlənsˈbɒndˈθɪəri]	l) воронка Бюхнера
13. molecular orbital	13) [ˈkrɪstlˈlætɪs]	m) атомная масса

14.oxidation-reduction (redox) reaction	14) [aɪ'ɒnɪk'bɒnd]	n) закон сохранения массы
15.periodic law	15) ['bɪkɒnə'fʌn(ə)l]	o) молярная масса
16.valence bond theory	16) [mæg'netɪk'stɜ:rə]	p) ковалентная связь

6. For each definition (1-16) choose a suitable term from task 5.

- 1) The number of molecules in a mole of a substance (approximately 602,250,000,000,000,000,000).
- 2) The mass of an atom of a chemical element expressed in atomic mass units.
- 3) A regular three-dimensional geometric arrangement of atoms, molecules or ions in a crystal.
- 4) A laboratory device that employs a rotating magnetic field to cause a stir bar immersed in a liquid to spin very quickly, thus stirring it.
- 5) A quantum mechanical formulation of the classical concept of chemical bond wherein the molecule is regarded as a set of atoms held together by local bonds.
- 6) A physical property, the mass of a given substance divided by its amount of substance.
- 7) The principle that states that for any system closed to all transfers of matter and energy, the mass of the system must remain constant over time, as system mass cannot change quantity if it is not added or removed.
- 8) A type of chemical bond formed through an electrostatic attraction between two oppositely charged ions.
- 9) The chemical bond that involves the sharing of pairs of electrons between atoms.
- 10) A standards-defined quantity that measures the size of an ensemble of elementary entities, such as atoms, molecules, electrons, and other particles.
- 11) The structure of an atom, theoretically consisting of a positively charged nucleus surrounded and neutralized by negatively charged electrons revolving in orbits at varying distances from the nucleus, the constitution of the nucleus, and the arrangement of the electrons differing with various chemical elements.
- 12) A piece of laboratory equipment used for filtration, a ceramic funnel with a flat base on which the filter paper is laid flat; normally used with a vacuum pump.
- 13) The quantum mechanical behavior of an electron in a molecule describing the probability of the electron's particular position and energy; approximated by a linear combination of atomic orbitals.
- 14) A chemical reaction in which some of the atoms have their oxidation number changed.
- 15) An attraction between atoms that allows the formation of chemical substances that contain two or more atoms, caused by the electrostatic force of attraction between

opposite charges, either between electrons and nuclei or as the result of a dipole attraction.

- 16) The principle that chemical properties of the elements are periodic functions of their atomic numbers.

7. Complete the paragraphs using the terms from task 5. In some sentences, the plural form is required. In each paragraph, the same word is missing.

- 1) The molecular mass and relative molecular mass are distinct from but related to the _____. The _____ is defined as the mass of a given substance divided by the amount of a substance and is expressed in g/mol. The _____ is usually the more appropriate figure when dealing with macroscopic (weigh-able) quantities of a substance. The _____ M is a physical property. The term relative _____ is also used. This is defined as “the average mass of the molecule divided by 1/12 of the mass of an atom of the nuclide C12.” The older term molecular weight is still widely used by polymer technologists.
- 2) _____ is a reaction in which electrons are transferred between species or in which atoms change oxidation number. _____ in glasses play an important role in the high-temperature chemistry of glass melting reactions. Changes in the oxidation state of transition metal ions dissolved in glass are of considerable scientific and technological interest. An _____ corresponds to a chemical reaction that involves the transference of electrons from one species to another. In _____, as the proper name suggests, there is a simultaneous occurrence of the phenomena of oxidation and reduction, because the existence of one depends on the occurrence of the other.
- 3) The _____ in a given sample of matter is defined as the number of discrete atomic-scale particles in it divided by the Avogadro constant N_A . In a truly atomistic view, the _____ is simply the number of particles that constitute the substance. The particles or entities may be molecules, atoms, ions, electrons, or others, depending on the context. The _____ is sometimes referred to as the chemical amount.
- 4) A _____ is a mutual electrical attraction between the valence electrons and nuclei of different atoms that bind together. _____ are considered in light of the correlation of valence electrons that is strengthened when the bond is dissociated. The _____ is the central concept in chemistry, which has been considered and investigated by many scientists and which will undoubtedly be further studied. NMR spectroscopy has provided valuable experimental data bringing detailed information on _____ not accessible by other experimental techniques.

- 5) The _____ states that the physical and chemical properties of the elements recur systematically and predictably when the elements are arranged in order of increasing atomic number. Many of the properties recur at intervals. When the elements are arranged correctly, the trends in element properties become apparent and can be used to make predictions about unknown or unfamiliar elements, simply based on their placement on the table.
- 6) The _____ of chemical compounds are almost as various as the compounds themselves. The arrangement of the atoms in a _____ is customarily described by stating their coordinates. Plastic deformation is produced in the _____ of the ball-milled powders by slip and twinning.
- 7) The relative _____ of an atom is a dimensionless number indicating how many times the _____ is greater than the _____ unit. Similarly, the relative molecular mass of a molecule is a dimensionless number indicating how many times the molecular mass is greater than the _____ unit. The relative molecular mass can be calculated as a sum of all relative _____ of all atoms of a molecule. The _____ unit is defined as 1/12 of the mass of the carbon isotope nuclide.
- 8) The _____, the number of entities in the amount of substance of one mole, links the atomic and the macroscopic properties of matter. Since the molar Planck constant is very well known via the measurement of the Rydberg constant, the _____ is also closely related to the Planck constant. In addition, its accurate determination is of paramount importance for a new definition of the kilogram in terms of a fundamental constant.
- 9) To apply a uniform vacuum on the pericardium, the 60mm stainless steel ring and filtration _____ with Uniform holes were used. To perform vacuum washing, every decellularized tissue was cut in 75mm diameter and fixed via a stainless-steel ring with 60mm diameter in the center of filtration _____ which was connected to a glass filtration flask. The system was connected to a vacuum pump by a hose, and negative pressure of -100 mmHg was applied for 15 min.
- 10) Nuclear properties are related to the _____ of the matter: An atom consists of a nucleus and a number of orbiting electrons e^- . Classical thermodynamics was developed before _____ and the equivalence of heat and light were understood, resulting in serious shortcomings.
- 11) _____ are formed by the actual transfer of electrons, which produces positively and negatively charged electrons. Formation of the _____ leads to the lowering of energy because of electrostatic attraction between ions of opposite charge.
- 12) A _____ can be defined as the increased probability of finding electrons between two atoms resulting from electron sharing. A single _____ in which both electrons

in the shared pair come from the same atom is called a coordinate _____. To indicate a coordinate _____ an arrow is sometimes drawn from the atom that donates the electron pair toward the atom with which the pair is shared.

- 13) _____ are often used in chemistry and biology, where they can be used inside hermetically closed vessels or systems, without the need for complicated rotary seals. They are preferred over gear-driven motorized stirrers because they are quieter, more efficient, and have no moving external parts to break or wear out (other than the simple bar magnet itself). Magnetic stir bars work well in glass vessels commonly used for chemical reactions, as glass does not appreciably affect a magnetic field. The limited size of the bar means that _____ can only be used for relatively small experiments, of 4 liters or less.
- 14) In the _____ treatment of bond formation, we visualize electrons filling the _____ one by one in the same way as atomic orbitals are filled. The rules are summarized here in terms of _____. 1. Electrons first occupy the _____ of lowest energy; they enter higher-energy _____ only when the lower-energy orbitals are filled. 2. Each _____ can accommodate a maximum of two electrons (Pauli exclusion principle). 3. _____ of equal energy are occupied by single electrons before electron pairing begins (Hund principle).
- 15) _____ provides a physical picture of chemical structure using the concepts of classical electrostatics in a way that avoids the need for quantum mechanics. It is an extension of the atom-bond model of chemical structure which, when it was introduced in the 19th century, successfully described the structures of organic molecules using just two concepts: atoms and bonds, and one property: the valence of the atom, defined as the number of bonds that the atom forms. _____ and quantum theory are complementary.
- 16) The fluid control equations consist of three main equations: the continuity equation, the momentum conservation equation, and the energy conservation equation. They are essentially the _____, Newton's motion law, and energy conservation law, respectively.

8. Put the parts in order to form a sentence.

- 1) molecules/ in organic/ as/ components/ are common/ of matter/ substances/
- 2) beakers/ contained/ with lines/ graduated/ that is/ marked on/ are often/ indicating/ the side/ the volume/
- 3) disintegration/ mass/ seems/ or protons/ reflected/ of electrons/ of atomic/ in the total/
- 4) neutrons/ source/ in an atomic/ used as/ are generally/ produced/ the radiation/ reaction/
- 5) an isotope/ element/ two/ forms chemical/ or more/ of/ the same/ is one of/

- 6) sublimation/ to gas/ or volatilization/ through/ solid/ is a change/ of state/ without passing/ the liquid/ state/ from/
- 7) oxidation/ reactions/ chemistry/ are essential/ transformations/ in industrial/
- 8) the chemical/ between/ two or more/ of electrons/ bond/ is the sharing/ atoms/
- 9) metals/ crystal/ have/ translational/ symmetry/ lattices/ and semiconductors/ with a well-defined/
- 10) a mole/ is Avogadro's number/ of particles/ substance/ of any/

9. Find 22 hidden terms in the word search puzzle. The terms are directed forward →, back ←, down ↓, up ↑ and diagonally ↘, ↙, ↖, ↗. There are terms made up of one, two or more words. The words do not belong together, but they are fused in the puzzle. One of the terms is marked.

k	t	n	a	t	s	n	o	c	o	r	d	a	g	o	v	a	n	u
m	t	a	x	h	n	o	r	t	u	e	n	x	v	w	h	r	v	s
d	o	s	t	c	h	e	m	i	c	a	l	b	o	n	d	p	y	d
w	f	l	g	o	k	r	e	b	m	f	y	k	e	y	l	c	s	f
o	n	c	e	d	m	r	r	e	m	o	n	o	m	n	n	e	u	y
x	j	i	r	c	g	i	w	b	m	t	r	j	k	e	l	o	b	e
i	z	s	n	b	u	g	c	v	d	w	v	y	l	e	r	g	l	l
d	e	o	w	c	s	l	t	s	k	y	u	a	c	l	b	e	i	u
a	l	t	m	a	i	u	a	r	t	k	v	t	x	k	t	t	m	h
t	u	o	w	o	l	s	p	r	l	r	r	t	f	r	k	t	a	s
i	c	p	s	q	l	c	o	i	o	o	u	m	o	t	a	e	t	s
o	e	e	c	a	b	a	i	m	n	r	p	c	l	m	p	r	i	a
n	l	z	x	e	n	h	r	d	e	q	b	y	t	r	j	u	o	m
a	o	d	a	o	h	j	k	m	o	r	t	i	f	u	u	b	n	c
s	m	k	t	h	t	d	s	e	a	i	i	b	t	h	r	h	t	i
s	e	o	z	k	q	a	n	g	u	s	r	s	s	a	d	e	i	m
r	r	w	v	b	f	t	g	n	p	l	s	e	m	b	l	z	r	o
p	t	e	d	n	o	b	c	i	n	o	i	k	p	a	a	s	s	t
a	m	o	u	n	t	o	f	s	u	b	s	t	a	n	c	e	w	a

10. Translate the sentences into Russian. Pay attention to the terms in bold.

- 1) Optimal reflector materials are those having large scattering cross-sections and low **atomic masses**.
- 2) **Isotopes** are different forms of the same element that are different from each other according to the number of neutrons they have in their nuclei.
- 3) **Molecular orbital** (MO) theory uses a linear combination of atomic orbitals (LCAO) to represent **molecular orbitals** involving the whole molecule.
- 4) Most important among the **crystal lattices** are the simple cubic, body-centered cubic, and face-centered cubic structures, the diamond structure, and the hexagonal close-packed structure.
- 5) The key properties that follow trends according to **Periodic Law** are atomic radius, ionic radius, ionization energy, electronegativity, and electron affinity.
- 6) Depending on the nature of the solid, **sublimation** can occur at atmospheric pressure or vacuum.
- 7) The unique properties of water center upon its **atomic structure** and bonding and the unusual association of water molecules in solid, liquid, and gaseous phases.
- 8) **Redox reactions** play a vital role in the chemical transformation processes of inorganic substances, including dissolution.
- 9) The mixing between biodiesel and diesel was carried out at room temperature using a **magnetic stirrer** to obtain a uniform mixture.
- 10) In acid value testing, two solutions have to be prepared such as a **burette** solution and **beaker** solution.
- 11) A **covalent bond** forms when the difference between the electronegativities of two atoms is too small for an electron transfer to occur to form ions.

11. Reading and discussion

- a) **Read the text and say in what way understanding the properties of the proton helps physicists answer some of the most fundamental questions.**

Nature's funhouse mirror: Understanding ... in the proton

Source link: <https://www.sciencedaily.com/releases/2021/02/210224143458.htm>

Date: February 24, 2021

Source: DOE/Argonne National Laboratory

Summary: The results of a new experiment could shift research of the proton by reviving previously discarded theories of its inner workings.

Asymmetry in the proton confounds physicists, but a discovery may bring back old theories to explain it.

Symmetry -- displayed in areas ranging from mathematics and art to living organisms and galaxies -- is an important underlying structure in nature. It characterizes our universe and enables it to be studied and understood.

Because symmetry is such a pervasive theme in nature, physicists are especially intrigued when an object seems like it should be symmetric, but it isn't. When scientists are confronted with these broken symmetries, it's as if they've found an object with a strange reflection in the mirror.

"Nature is leading the way for concepts in older models of the proton to get a second look." -- Argonne physicist Don Geesaman

The proton, a positively charged particle that exists at the center of every atom, displays asymmetry in its makeup. Physicists at the U.S. Department of Energy's (DOE) Argonne National Laboratory and their collaborators recently investigated the intricacies of this known broken symmetry through an experiment conducted at DOE's Fermi National Accelerator Laboratory. The results of the experiment could shift research of the proton by reviving previously discarded theories of its inner workings.

The outcome of this experiment contradicts the conclusion of a study from the late 90s, also performed at Fermilab. Scientists can now revisit theories to describe asymmetry in the proton that were ruled out by the old experiment.

Understanding the properties of the proton helps physicists answer some of the most fundamental questions in all of science, and by investigating the world at the smallest level, scientists are advancing the technology we use every day. Studies of the proton have led to the development of proton therapy for cancer treatment, measurement of proton radiation during space travel, and even understanding of star formation and the early universe.

"We were able to look at the puzzling dynamics within the proton," said Argonne physicist Don Geesaman, "and through this experiment, nature is leading the way for concepts in older models of the proton to get a second look."

Mismatched matter

Just as shapes can have symmetry, particles can, too. A perfect circle consists of two semicircles of the same size facing opposite directions, and each type of particle in the universe has an antiparticle of the same mass with an opposite electric charge.

The building blocks of the proton include particles called quarks, and their antiparticles, called antiquarks. They come in "flavors," such as up, down, anti-up and anti-down. Quarks and antiquarks are bound together inside the proton by a strong nuclear

force. The strength of this force can pull pairs of quarks and antiquarks out of nothing, and these pairs exist for a short time before annihilating each other. This "sea" of quarks and antiquarks popping in and out of existence is ever-present inside the proton.

Curiously, at any given time, there are three more quarks than antiquarks: two more up quarks than anti-up quarks, and one more down quark than anti-down quarks. In other words, these mismatched quarks have no antimatter counterparts. This asymmetry is the reason protons are positively charged, allowing atoms -- and therefore all matter -- to exist.

"We still have an incomplete understanding of quarks in a proton and how they give rise to the proton's properties," said Paul Reimer, an Argonne physicist on the study. "The fleeting nature of the quark-antiquark pairs makes their presence in the protons difficult to study, but in this experiment, we detected the annihilations of the antiquarks, which gave us insight into the asymmetry."

The experiment determined that there are always more anti-down quarks in the proton than anti-up quarks, no matter the quarks' momentums. The significance of this result is its contradiction with the conclusion of the Fermilab experiment in the late 90s, which suggested that at high momentums, the proton's asymmetry reverses, meaning the anti-up quarks begin to dominate anti-down quarks.

"We designed the new experiment to look at these high momentums to determine if this change occurs," said Reimer. "We showed that there is a smooth asymmetry with no flip of the ratio between anti-up and anti-down quarks."

Reconstructing annihilation

To probe the quarks and antiquarks in the proton, the scientists shot beams of protons at targets and studied the aftermath of the particle collisions. Specifically, they studied what happens after a proton from the beam hits a proton in the target.

When protons collide, quarks and antiquarks from the protons annihilate each other. Then, two new fundamental particles called muons come out of the annihilation, acting as the interaction's signature. From these interactions, the scientists determined the ratio of anti-up quarks to anti-down quarks at a range of high momentums.

"We chose to measure muons because they can pass through material better than most of the other collision fragments," said Reimer. In between the targets and their measurement devices, the team placed a five-meter-thick iron wall to stop other particles from passing through and clouding their signals.

When the muons hit the measurement devices at the end of their journey, the scientists reconstructed the quark-antiquark annihilations from the measurements, enabling them to confirm the smooth, consistent ratio of anti-up quarks to anti-down quarks.

A second look

"What we thought we saw in the previous experiment isn't what happens," said Geesaman, who was part of both the present and previous studies. "Why, though? That's the next step."

Theories that were rejected after they contradicted the previous experiment's results now give a great description of the new data, and scientists can revisit them with greater confidence because of this experiment. These theories will inform further experiments on asymmetry in the proton and other particles, adding to our understanding of the theory surrounding quarks.

Clues about the nature of quarks in the proton ultimately lead to a better understanding of the atomic nucleus. Understanding the nucleus can demystify properties of the atom and how different chemical elements react with each other. Proton's research touches upon fields including chemistry, astronomy, cosmology, and biology, leading to advances in medicine, materials science, and more.

"You need an experiment to lead the thinking and constrain theory, and here, we were looking for nature to give us insight into the proton's dynamics," said Geesaman. "It's an interlacing cycle of experiment and theory that leads to impactful research."

b) Read the text again and determine which of the following statements match the content of the text (True), do not match (False), and what is not given in the text (Not Stated).

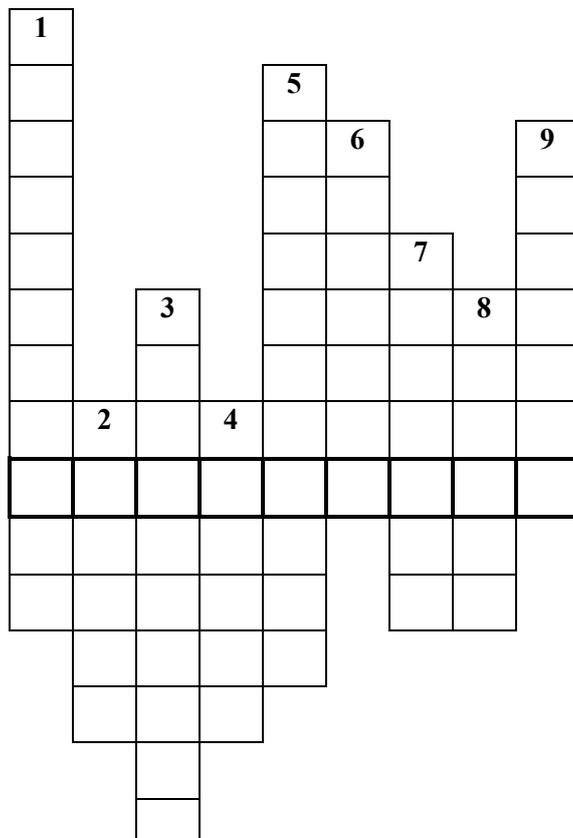
- 1) Asymmetry is an important underlying structure in nature, characterizing our universe and displayed in different areas.
- 2) The proton, a positively charged particle that exists at the center of every atom, displays asymmetry in its makeup.
- 3) The experiment determined that there are always more anti-down quarks in the proton than anti-up quarks, no matter the quarks' momentums.
- 4) Theories were confirmed by both experiments on asymmetry in the proton and these results now give a great description of the theories.
- 5) Understanding the nucleus can demystify properties of the atom and how different chemical elements react with each other.

c) Complete the sentences from the text and you can see the word that is missing in the title of the article.

- 1) When protons collide, quarks and antiquarks from the protons ... each other.
- 2) Studies of the proton have led to the measurement of proton radiation during ... travel and even understanding of star formation and the early universe.
- 3) "We still have an incomplete understanding of quarks in a proton and how they give rise to the proton's properties," said Paul Reimer, an Argonne ... on the study.
- 4) Then, two new fundamental particles called ... come out of the annihilation, acting as the interaction's signature.
- 5) The results of the ... could shift research of the proton by reviving previously discarded theories of its inner workings.
- 6) Clues about the ... of quarks in the proton ultimately lead to a better understanding of the atomic nucleus.
- 7) Understanding the properties of the ... helps physicists answer some of the most fundamental questions in all of science.
- 8) Quarks and antiquarks are bound together inside the proton by a strong nuclear
....

9)

10) "It's an interlacing cycle of experiment and ... that leads to impactful re-search."



d) Visit one of the websites <https://academic.oup.com/>, <http://abc-chemistry.org/>, <http://www-jmg.ch.cam.ac.uk/data/c2k/cj/> or any other website publishing research articles in Chemistry, choose an article, read and summarize its content using the plan and useful phrases in the Appendix. The length of the summary should be about 10 % of the original text.

Unit 2. Inorganic Chemistry

1. Read the text and tell why this discipline might be called basic and what its research is aimed at.

Inorganic chemistry is the branch of chemistry concerned with the investigation of the properties of all elements, and the properties and methods of syntheses of their compounds, except for carbon and most carbon-containing compounds. (The study of some carbon-containing compounds—such as carbon dioxide, carbonates, and cyanides—is considered part of inorganic chemistry.) This field stands in a complementary relationship to organic chemistry, which covers the myriad of carbon-based compounds. These two disciplines are generally considered separately, but there is much overlap, such as in the sub-discipline of organometallic chemistry.

Important classes of inorganic compounds include oxides, sulfides, sulfates, carbonates, nitrates, and halides. Many of them are found in inanimate materials, such as minerals. For example, soil may contain iron sulfide as pyrite or calcium sulfate as gypsum. Some inorganic compounds are found in biological systems, such as in the form of electrolytes (sodium chloride).

The study of inorganic chemistry has led to enormous benefits in practical terms. Traditionally, the scale of a nation's economy could be evaluated by its productivity of sulfuric acid. In 2005, the top 20 inorganic chemicals manufactured in Canada, China, Europe, Japan, and the United States were (in alphabetical order): Aluminum sulfate, ammonia, ammonium nitrate, ammonium sulfate, carbon black, chlorine, hydrochloric acid, hydrogen, hydrogen peroxide, nitric acid, nitrogen, oxygen, phosphoric acid, sodium carbonate, sodium chlorate, sodium hydroxide, sodium silicate, sodium sulfate, sulfuric acid, and titanium dioxide.

Most inorganic compounds occur as salts, in which cations and anions are held together by ionic bonds. Examples of cations are sodium (Na^+) and magnesium (Mg^{2+}); examples of anions are oxide (O^{2-}) and chloride (Cl^-). These ions form compounds such as sodium oxide (Na_2O) or magnesium chloride (MgCl_2), which are neutral in their overall charge. The ions are described by their oxidation state and their ease of formation can be inferred from the ionization potential (for cations) or the electron affinity (for anions) of the parent elements.

Many inorganic compounds are characterized by high melting points. Inorganic salts typically are poor conductors in the solid state. Other characteristic properties of inorganic compounds are their solubility in water (and other solvents) and ease of crystallization. Some compounds (such as sodium chloride, NaCl) are very soluble in water, others (such as silicon dioxide, SiO_2) are not.

A simple inorganic reaction is a double displacement, in which the ions of two salts are swapped without a change in oxidation state. In redox reactions, the oxidation state of one reactant, the oxidant, decreases, and that of the other reactant, the reductant, increases. The net result is an exchange of electrons. Electron exchange can occur indirectly as well, such as in electrical batteries—a key feature in electrochemistry.

Some inorganic compounds are acids or bases, and they undergo acid-base reactions. By the Brønsted-Lowry definition, an acid is a proton (hydrogen ion) donor; a base is a proton acceptor. By the Lewis definition, which is more general, any chemical species capable of binding to an electron pair is called a Lewis acid; conversely, any molecule that tends to donate an electron pair (to form a bond) is called a Lewis base.

The first important man-made inorganic compound was ammonium nitrite for soil fertilization through the Haber process. Inorganic compounds are synthesized for use as catalysts such as vanadium(V) oxide and titanium(III) chloride, or as reagents in organic chemistry such as lithium aluminum hydride.

Subdivisions of inorganic chemistry are organometallic chemistry, cluster chemistry, and bioinorganic chemistry. These fields are active areas of research in inorganic chemistry, aimed toward new catalysts, superconductors, and therapies.

Source link: https://www.newworldencyclopedia.org/entry/Inorganic_chemistry

2. Match the terms (1-30), transcriptions (1-30), and translations (a-dd).

1) acid	1. [ə'məʊniə]	a) фосфор
2) actinide	2. ['ɑ:ɪdi:n]	b) аммиак
3) alkaline	3. [beɪ'sɪsɪtɪ]	c) интерметаллический
4) aluminium	4. ['fɒsfərəs]	d) олеум
5) ammonia	5. ['naɪtrədʒən]	e) хлор
6) amphoteric	6. ['ælkələɪn]	f) фосфин
7) basicity	7. [haɪ'drɒksaɪd]	g) гидроксид
8) chlorine	8. ['ɒvlɪəm]	h) кислота
9) clathrate	9. [ˌpɒlɪ'mɔ:fiʒ(ə)m]	i) нитрат калия, селитра
10) Glauber's salt	10. ['ɒksɪdʒən]	j) озон
11) hydroxide	11. ['fɒsfi:n]	k) азот
12) intermetallic	12. ['sɔ:lt, pi:tə(r)]	l) пирит
13) iodine	13. ['æsaɪd]	m) оксид

14) Lewis acid	14. [ˈpaɪ(ə)raɪt]	n) полиморфизм
15) nitrogen	15. [ˈklæθreɪt]	o) редкоземельный элемент
16) oleum	16. [trænˈzɪfnˈelɪmənt]	p) актиноид
17) oxide	17. [ˈprɒksɪd]	q) берлинская лазурь
18) oxygen	18. [ˈæljʊˈmɪniəm]	r) переходный элемент
19) ozone	19. [ˌɪntəˈmɪˈtæɪk]	s) щелочной
20) phosphine	20. [ˈæktɪnaɪd]	t) клатрат
21) phosphorus	21. [ˈluːɪsˈæsɪd]	u) йод
22) polymorphism	22. [ˌrɛərˈz:θ]	v) сера
23) precious metal	23. [ˈklɔːrɪ:n]	w) алюминий
24) prussian blue	24. [ˈsɪlfə]	x) амфотерный
25) pyrite	25. [juˈreɪnɪəm]	y) кислота Льюиса
26) rare earth	26. [ˈæmfəˈteɪk]	z) Глауберова соль
27) saltpeter	27. [ˈɒksaɪd]	aa) основность
28) sulphur	28. [ˈglɔːbɜːzˈɔːlt]	bb) уран
29) transition element	29. [ˈəvzəʊn]	cc) кислород
30) uranium	30. [ˈpreʃəsˈmetl]	dd) благородный (драгоценный) металл

3. For each definition (1-30) choose a suitable term from task 2 (1-30).

- 1) A nonmetallic chemical element with an atomic number of 16 that is a member of the chalcogen family that exists in coal in three forms: organic, pyritic, and sulfate.
- 2) An insoluble dark, bright blue pigment, ferric ferrocyanide.
- 3) A multivalent nonmetallic chemical element with an atomic number of 15, of the nitrogen family that occurs commonly in inorganic phosphate rocks and as organic phosphates in all living cells; is highly reactive and occurs in several allotropic forms.
- 4) A colorless gaseous alkaline compound that is very soluble in water, has a characteristic pungent odor, is lighter than air, and is formed as a result of the decomposition of most nitrogenous organic material, produced when nitrogen is removed from a petroleum fraction by hydrotreating.
- 5) Relating to or containing an alkali; having a pH greater than 7.
- 6) A compound in which one component is physically enclosed within the crystal structure of another.

- 7) Materials consisting of a combination of different metals, which results in an ordered crystallographic structure that forms when the concentration of the alloys exceeds the solubility limit.
- 8) Any of various water-soluble compounds having a sour taste and capable of turning litmus red and reacting with a base to form a salt.
- 9) A light, silvery metal extracted from bauxite, and a chemical element (symbol Al) with an atomic number of 13.
- 10) A colorless nonmetallic element of atomic number 7, tasteless and odorless, comprising four-fifths of the atmosphere by volume in the form of molecular gas.
- 11) A binary chemical compound in which oxygen is combined with a metal or non-metal.
- 12) A colorless gas, analogous to ammonia, and having a disagreeable odor resembling that of garlic.
- 13) The common mineral iron disulfide, of a pale brass-yellow color and brilliant metallic luster, crystallizing in the isometric system.
- 14) One of a group of metallic elements in which the members have the filling of the outermost shell to 8 electrons interrupted to bring the penultimate shell from 8 to 18 or 32 electrons; includes elements 21 through 29 (scandium through copper), 39 through 47 (yttrium through silver), 57 through 79 (lanthanum through gold), and all known elements from 89 (actinium) on, that have multiple valencies and form colored compounds and stable complex ions.
- 15) The potassium salt of nitric acid; used in the production of nitric acid, as a food preservative, and is used in toothpaste for sensitive gums.
- 16) Any of a group of seventeen soft, lustrous, sometimes magnetic metals that form trivalent salts; which include the lanthanides plus yttrium, scandium, thorium, and sometimes zirconium.
- 17) A metal that is rare and has a high economic value, due to various factors, including its scarcity, use in industrial processes, and role throughout history as a store of value, the most popular are gold, platinum, and silver.
- 18) A colorless gas soluble in alkalis and cold water; a strong oxidizing agent; can be produced by electric discharge in oxygen or by the action of ultraviolet radiation on oxygen in the stratosphere (where it acts as a screen for ultraviolet radiation).
- 19) A diatomic anion with the chemical formula OH^- which consists of an oxygen and a hydrogen atom held together by a covalent bond and carries a negative electric charge.
- 20) Having the characteristics of both an acid and a base, and capable of reacting as either; amphoteric.
- 21) The condition of being a base, or the difficulty for acid to react with a base determined by the number of hydrogen atoms that can be replaced in the acid.

- 22) A heavy toxic silvery-white radioactive metallic element with atomic number 92; occurs in many isotopes; used for nuclear fuels and nuclear weapons.
- 23) Fuming sulphuric acid refers to a solution of various compositions of sulfur trioxide in sulphuric acid, or sometimes more specifically to disulphuric acid, that can be described by the formula $y\text{SO}_3 \cdot \text{H}_2\text{O}$ where y is the total molar sulfur trioxide content.
- 24) Any electrophilic compound that can accept a pair of electrons and form a coordinate covalent bond.
- 25) A common nonmetallic chemical element belonging to the halogens, with an atomic number of 17; a heavy yellow irritating toxic gas; used to purify water and as a bleaching agent and disinfectant.
- 26) Any of the series of 15 chemically similar, radioactive metallic chemical elements with atomic numbers ranging from 89 to 103, actinium through lawrencium.
- 27) Sodium sulfate decahydrate, $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$, that occurs as white or colorless monoclinic crystals.
- 28) A colorless, tasteless, odorless, gaseous element of atomic number 8, occurring in the free state in the atmosphere, of which it forms about 23 per cent by weight and about 21 per cent by volume, being slightly heavier than nitrogen.
- 29) A nonmetallic element belonging to the halogens with an atomic number of 53; used especially in medicine and photography and in dyes; occurs naturally only in combination in small quantities (as in sea water or rocks).
- 30) The ability of a solid material to exist in more than one form or crystal structure of the same chemical compound.

4. Complete the paragraphs using the terms from task 2. In some sentences, the plural form is required. In each paragraph, the same word is missing.

- 1) _____ are formed from the interaction of heated particles with the surrounding atmosphere (in-flight oxidation) or heating of the coating surface during deposition (postimpact oxidation). _____ in essential oils have an oxygen atom within a ring structure, usually made from alcohol, and are named after the alcohol with the termination _____, e.g. linalool _____. _____ form a class of material that covers almost all the spectra of functionalities: dielectric, semiconductor, metallic, superconductor, optically non-linear, piezoelectric, ferroelectric, ferromagnetic, etc.
- 2) _____ is a medium-sized atom located at the intersection of the 16th group (column) and the 3rd period (row) of the periodic table. _____ in coal exists in three forms: organic, pyritic, and sulfate. _____ that is an inherent constituent of coal is organic _____, which is considered as a non-removable impurity. Pyritic _____ occurs primarily as pyrite or marcasite. Sulfate _____ usually exists as calcium

sulfate or iron sulfate. When coal is burned, _____ oxides form and emit through the stack. However, the quantity of _____ oxides emission to the atmosphere should comply with local air pollution control regulations.

- 3) _____ atoms are more powerful oxidants than ozone and produce chemiluminescence with a wide range of analytes. Nevertheless, the analytical application of this reagent is very limited. One reason for this is that the five different excited states of molecular _____ formed in the recombination of _____ atoms produce a background emission across the entire visible region that increases quadratically with _____ atom concentration.
- 4) _____ precipitation involves reacting the metals with _____ such as $\text{Ca}(\text{OH})_2$ or NaOH to form their respective _____. The redox conditions are maintained in the alkaline range of 8–11 where most of the metal _____ are insoluble precipitates which are then removed by flocculation or sedimentation. This method is used for almost all kinds of metal contaminations; however, _____ precipitation also has drawbacks in terms of producing low-density upper precipitates which require a lot of effort to separate from the reactors.
- 5) _____ owes its color to the presence of iron in two different valency states, allowing electrons to move from one orbit to another with great ease and giving rise to very strong absorption in the orange/red part of electromagnetic wavelengths, resulting in a strong reddish blue color.
- 6) _____ is an essential component of the thyroid gland and its deficiency in humans can provoke several mental and physical disorders. _____ is a very useful universal reagent, but it should never be overlooked that some reactions with _____ are non-reversible. The use of _____ as vapor enables the detection of separated substances rapidly and economically before final characterization with a group-specific reagent. Where lipophilic zones are present on a silica gel layer, the _____ molecules will concentrate in the substance zones giving brown chromatographic zones on a yellow background.
- 7) Nucleophilicity and _____ reflect the same property, namely the ability to share the lone electron pair (or pairs) with an electron acceptor; thus, to combine with an electrophilic substrate. Nucleophilicity is determined at kinetically controlled conditions whereas _____ is determined at conditions controlled thermodynamically (from the studies of equilibria).
- 8) _____ surfactants contain both anions and cations. _____ surfactants have several functional groups showing characteristics of anionic or cationic emulsifiers at high and low pH, respectively. They should show positive results when tested with either the basic methylene blue test for anionic surfactants or the alternative bromophenol blue test for cationic surfactants. A saturated bromine aqueous solution can also be used to determine the type of _____ surfactants.

- 9) _____ is a yellow-green gas that dissolves in water. The hypochlorous acid formed is readily ionized into hypochlorite ion: $\text{HOCl} \rightleftharpoons \text{H}^+ + \text{OCl}^-$. _____ is the most widely used water biocide. The amount which needs to be added to bring about disinfection is determined by _____ demand, contact time, water pH, and temperature. When _____ gas is mixed with water, it forms hypochlorous and hydrochloric acid. The dose of _____ required is often determined based upon the amount of _____ remaining after reaction time, known as the free _____ residual.
- 10) An _____ is a molecule or ion capable of donating a proton (hydrogen ion H^+), or capable of forming a covalent bond with an electron pair. Reactions of _____ are often generalized in the form $\text{HA} \rightleftharpoons \text{H}^+ + \text{A}^-$, where HA represents the _____ and A^- is the conjugate base. This reaction is referred to as protolysis. The protonated form (HA) of an _____ is also sometimes referred to as the free _____.
- 11) _____ hydrate is an inclusion compound of which the cage-like structure formed by hydrogen-bonded water molecules can hold gas molecules in it. In general, _____ hydrates are thermodynamically stable under low-temperature and high-pressure conditions. A variety of applications of gas hydrates has been studied recently, especially in the field of gas storage and transportation, disposal of CO_2 , and gas separation. _____ hydrates are a little like zeolites, in that they encage small gas molecules in a framework of hydrogen-bonded water molecules. Known for around 200 years, these gas hydrates were only recently found to exist in nature.
- 12) _____ catalyze several different types of aromatic reactions, including alkylation, polymerization, isomerization, acylation, and halogenation. The efficacy for various reactions is very dependent on the nature of the Brønsted-Lowry or _____. _____ such as aluminoorganic compounds and boron halides cannot initiate polymerization of styrenes in rigorously purified and dried solvents.
- 13) _____ is remarkable for its low density and its ability to resist corrosion through the phenomenon of passivation. _____ and its alloys are vital to the aerospace industry and important in transportation and building industries, such as building facades and window frames. The oxides and sulfates are the most useful compounds of _____. _____ metal has an appearance ranging from silvery white to dull gray, depending on the surface roughness. A fresh film of _____ serves as a good reflector (approximately 92%) of visible light and an excellent reflector (as much as 98%) of medium and far-infrared radiation. _____ alloys are the most widely used non-ferrous metals in engineering owing to their attractive properties, such as high strength-to-weight ratio, good ductility, good corrosion resistance, availability, and low cost.
- 14) _____ solutions containing NaOH or KOH, sometimes supplemented with hypochlorite, are particularly effective for solubilizing fats and proteins. The _____

electrolyte system has the advantage of higher conductivity over the salt water system, which results in a high discharge rate for the battery. In addition to anode alloying, the _____ electrolyte can be modified by introducing corrosion inhibitors or complexing agents to make the electrolyte less corrosive, though the addition of alloying elements to the solution is known to be less effective than electrode alloying.

- 15) Sodium sulfate decahydrate $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$, commonly called _____ after its discoverer, Johann Rudolf Glauber, is the most widely used inorganic PCM and was the first to be employed in building applications. Its use has been traditionally marred by extensive subcooling, phase segregation, and incongruent melting phenomena, but each problem has been successfully solved.
- 16) Metallic alloys, _____, and metallic compounds are potential candidates for alternative plasmonic materials owing to their large free electron densities. _____ compounds form between pad metallization and the active components of the molten solder (typically tin). For a copper metallization, the tin reacts to form Cu_3Sn and Cu_6Sn_5 _____. For nickel, the tin reacts to form Ni_3Sn_4 . After solidification, the _____ compounds continue to grow by solid-state diffusion.
- 17) _____ is a surface-active element, N-atoms arrive at the surface, combine there to form molecules, and then desorb to the surrounding gas or vacuum space. _____ is the most abundant uncombined element accessible to man. It comprises 78.1% by volume of the atmosphere (i.e. 78.3 atom% or 75.5 wt%) and is produced industrially from this source on the multi-megatonne scale annually. In combined form, it is essential to all forms of life, and constitutes, on average, about 15% by weight of proteins. The industrial fixation of _____ for agricultural fertilizers and other chemical products is now carried out on a vast scale in many countries, and the number of moles of anhydrous ammonia manufactured exceeds that of any other compound. Indeed, of the top fifteen “high-volume” industrial chemicals produced in the USA, five contain _____.
- 18) _____ is a by-product of the curing of die adhesives, which contain the curing agent dicyandiamide ($\text{C}_2\text{H}_4\text{N}_4$). _____ vapor is often employed in improving the sensitivity of visualization of organic acids where pH indicators like bromocresol green or bromophenol blue have been used initially. The presence of _____ has the effect of giving a sharper contrast between the chromatographic zones and the plate background. The process of exposure to _____ vapor can be carried out simply by holding the chromatographic plate face down over a beaker of strong _____ solution. However, it can be done more elegantly by pouring _____ solution into one compartment of a twin trough developing tank and placing the TLC plate in the dry compartment.

- 19) _____ is a harsh reagent and is highly corrosive. One important use of _____ as a reagent is the secondary nitration of nitrobenzene. The first nitration can occur with nitric acid in sulphuric acid, but this deactivates the ring towards further electrophilic substitution. A stronger reagent, _____, is needed to introduce the second nitro group onto the aromatic ring. _____ is produced in the contact process, where sulfur is oxidized to sulfur trioxide which is subsequently dissolved in concentrated sulphuric acid. Sulphuric acid itself is regenerated by dilution of part of the _____.
- 20) _____ is a triatomic molecule consisting of three oxygen atoms, which is generated by sunlight-driven reactions involving the oxides of nitrogen and volatile organic compounds. _____ is an unstable molecule and, therefore, it cannot be stored in any way. Several reports are claiming that the half-life time of _____ in distilled water is about 20 min and it decreases to half when raw potable water is the dissolution medium. _____ is a highly reactive molecule formed by the atmospheric transformation of precursors in the presence of sunlight. Because of its reactive nature, _____ does not penetrate the body beyond the lungs. However, the reaction with surfactant and epithelial lining fluid can lead to the generation of reactive intermediates and often results in lung inflammation.
- 21) _____ is a limiting nutrient in aquatic water bodies, thereby controlling the growth of phototrophic organisms in aquatic waters and coastal marine systems. _____ is found in the earth and rocks, and it is taken up by plants and animals. _____ is a very important chemical because it is essential in the formation of DNA. In water bodies, _____ occurs almost entirely as organic phosphate and inorganic orthophosphate or polyphosphates. _____ is usually measured as total phosphorus (all forms combined) or dissolved _____. Dissolved orthophosphate (PO_3^-) is an important indicator of water pollution because it is easily and rapidly taken up by bacteria, and therefore is seldom found in high concentrations in unpolluted waters. The various _____ forms can be measured analytically by spectrophotometric techniques.
- 22) _____ are unique in many respects, from their radioactive nature, electronic configurations to oxidation states in various media. Compared to the well-studied chemistry of main group elements and transition metals, _____ are relatively poorly explored, although there have been many new findings in this field in recent years. No doubt, explorations about actinide inorganic synthesis have largely lagged behind those of other elements partly due to the obstacles for experimentally working with _____. As we know, all _____ are radioactive, and related laboratories should be well equipped, especially for manipulating transuranium elements. Therefore, the number of radiochemistry laboratories with the capability to deal with _____ is very limited.

- 23) _____ is defined as the ability to reveal different unit cell structures in crystals, originating from a variety of molecular conformations and molecular packing. _____ is a very widespread phenomenon in chemistry. It commonly occurs in both organic and inorganic chemistry and mineralogy and is also found for polymers and biochemicals. However, it is not straightforward to define it precisely. McCrone's first definition of _____, which is frequently quoted, is the ability of any element or compound "to crystallize as more than one distinct crystal species."
- 24) Potassium nitrate is an ionic salt of potassium ions K^+ and nitrate ions NO_3^- . Potassium nitrate is one of several nitrogen-containing compounds collectively referred to as _____. Major uses of potassium nitrate are in fertilizers, tree stump removal, rocket propellants, and fireworks. It is one of the major constituents of gunpowder (black powder). In processed meats, potassium nitrate reacts with hemoglobin and generates a pink color.
- 25) _____ is the dominant solid-phase form of sulfur in organic-matter-bearing marine sediments. _____ is cubic FeS_2 . Aggregated _____ consists of small _____ crystals forming irregular rounded clots, which may partly coalesce. Bladed crystals elongate and tend to occur as (rare) fillings in chambered organisms. Equant _____ consists of single crystals with well-developed crystal faces. _____ mineralization is also often found in the plant fossil record.
- 26) _____ compounds were considered until now only as an important class of ligands for various transition metals, but primary _____ and _____-boranes have a big potential for delivering oligomeric and polymeric materials. Metal-catalyzed coupling and dehydrocoupling of air-stable primary _____ and _____-boranes are terrifically attractive reactions for polymer chemistry. These reactions could be a route to exciting new polymer-based products. The very high chemical and thermal stability of phosphorus-boron compounds have attracted attention due to their potential use as thermoplastics. Polymeric _____-boranes, formed from transition metal-mediated dehydrocoupling, have significant potential to be technologically interesting materials.
- 27) As _____ alloys are usually very soft and therefore prone to be scratched and deformed, achieving such a high hardness is of great interest in jewelry applications. _____ are widely applied in various fields due to the distinct physical and chemical properties, such as catalytic activity, good electrical conductivity, and corrosion resistance.
- 28) As _____ are found in many different valence states, the relative sizes of the core and valence shell depend on the valence of the atom in a way that leaves the total charge density invariant. The d _____ atoms can contain up to five unpaired d electrons, and their compounds often also contain unpaired electrons. In contrast to inorganic compounds containing only representative elements, compounds of

many of the d _____ are paramagnetic and colored. The unpaired electrons are often responsible for the color of such compounds. Unpaired electrons are so readily elevated from the d level to higher energy levels that absorption of visible light provides enough energy to cause this change.

- 29) _____ are the seventeen elements within the lanthanide and actinide series of the Periodic Table, with thorium (Th) and neodymium (Nd) being the most commonly used as alloying elements. Despite their name, _____ are – except for the radioactive promethium – relatively plentiful in Earth's crust, with cerium being the 25th most abundant element at 68 parts per million, more abundant than copper. However, because of their geochemical properties, _____ are typically dispersed and not often found concentrated in _____ minerals; as a result economically exploitable ore deposits are less common.
- 30) _____ is an element of the actinide series, has an atomic number of 92 and, in its refined state, it is metallic silver in color, malleable, ductile, slightly paramagnetic, and very dense. There are several factors, such as _____ content in source, leachability, proximity and hydraulic isolation of water, climatic effects and their seasonal variability, pH, and oxidation state of the water, concentrations of carbonate, nitrates, phosphate and other species, overexploitation of groundwater, which can influence the levels of _____ dissolved in water. These factors coexist in many parts of the country and thus results in high _____ concentrations in groundwater.

5. Make words/word combinations by putting the entangled letters in the correct order.

- | | | |
|-------------------|-------------------|----------------|
| 1) eshphoinp | 6) aerr erhta | 11) onntegri |
| 2) horspushop | 7) ialnmniu | 12) pcahmtoeri |
| 3) eidydoxrh | 8) aleklain | 13) lhroecin |
| 4) ecruspio elamt | 9) mlhrpyiospom | 14) atrctehal |
| 5) eticidna | 10) tnclrilteamie | 15) peatrtesl |

6. Translate the sentences into English. The words in bold should be taken from the unit's list of terms.

- 1) **Кислота Льюиса** — это разновидность, которая принимает пару электронов от другой разновидности; другими словами, это акцептор электронной пары.
- 2) **Кислотно-основные реакции Бренстеда** — это реакции переноса протона, а **кислотно-основные реакции Льюиса** — это переносы пар электронов.
- 3) Карбаматы также могут образовываться при извлечении **аммиака** или синтезе амина, что приводит к непредвиденной технологической коррозии многих металлов и сплавов.
- 4) **Основность** молекулы — это мера ее способности принимать протон (H^+) с образованием стабильного продукта.
- 5) Газовые гидраты представляют собой **клатратные** соединения, состоящие из молекул газа-гостя и молекул воды, связанных водородными связями.
- 6) Растворы или настойки **йода** долгое время использовались медицинскими работниками в первую очередь в качестве антисептиков для кожи или тканей.
- 7) Степень разложения **озона** в жидкой фазе пропорциональна его разложению в газовой фазе.
- 8) **Фосфины, оксиды фосфина** и заместители на основе фосфора в целом являются очень привлекательными и полезными функциональными группами в органических системах.
- 9) **Полиморфизм** влияет на множество различных типов соединений, от минералогии, металлургии, материаловедения, пищевой промышленности до фармацевтической промышленности.
- 10) Сплавы **благородных металлов** сохраняют свою пассивность после литья и лабораторных процедур и хорошо подходят для защиты от химических внутритротовых химических воздействий.
- 11) Сульфаты **редкоземельных элементов** могут реагировать с сульфатом натрия, калия или аммония с образованием двойных сульфатных осадков.
- 12) Соединения **серы** адсорбируются на активных центрах на активной поверхности металла и ингибируют реакцию, блокируя адсорбцию реагентов.

7. Study the nomenclature of inorganic chemical compounds and fill in the gaps in the text. Materials are taken from <https://studyres.com/doc/15711245/chemistry>

Chemical nomenclature is a system of rules for naming chemical compounds which is to ensure that the name of every compound, whether spoken or written, matches a single substance, and, if possible, that the substance has a single name. The first attempt to provide a system of naming compounds goes back to the late 18th century (A. Lavoisier). It has been constantly refined. The present nomenclature of inorganic and organic compounds as recommended by IUPAC can be found in its Red Book and Blue Book, respectively. However, there exist other forms of naming depending on the user and addressee. Therefore, there is no single correct form of nomenclature, but there are various forms appropriate to the circumstances. The traditional system for naming inorganic compounds used below is intended for both non-specialist and specialist users among engineering students.

Naming inorganic compounds

A) Oxides

The nomenclature of oxides depends mainly on the number of oxides that the given element can form.

1) If the element forms only one oxide, the name of the element (cation) comes first, without any change (irrespective of the valence state of the element), followed by the word “oxide”, i.e. element + oxide.

e.g.: Al_2O_3 – aluminium oxide

- ZnO - _____
- CaO - _____
- K_2O - _____

2) If the given element can form more than one oxide, the valence state is taken into consideration. It is expressed by:

a) prefixes

mono- [ˈmɒnə-, ˈmɒno-, ˈmɒnəu]	pent(a)- [ˈpentə-/ penˈtæ-]
di- [dai-]	hex(a)- [ˈheksə-/ hekˈsæ-]
tri- [traɪ-]	hept(a)- [ˈheptə/, hepˈtæ-]
tetr(a)- [ˈtetrə-]	oct(a)- [ˈɒktə-/ ɒkˈtæ-]

The prefix becomes part of the word “oxide”.

element + mono/di...oxide

e.g.: NO_2 – nitrogen dioxide; N_2O_3 – nitrogen trioxide; N_2O_5 – nitrogen pentoxide

- SO_3 - _____
- Mn_2O_7 - _____

b) affixes

-ous [-əs] (for the lower valence state) -ic [-ik] (for the higher valence state)

The affix is added to the name of the cation to distinguish between the R_2O and RO types of oxides. They are used only with Latin names of elements:

cation of the element ...ous + oxide cation of the element ...ic + oxide

e.g.: N_2O – nitrous oxide; NO – nitric oxide

- Hg_2O - _____
- HgO - _____

c) prefix sesqui- [ˈseskwi-]

The prefix becomes part of the word “oxide” of the R_2O_3 type

element + sesquioxide

e.g.: Mn_2O_3 – manganese sesquioxide

- Cr_2O_3 - _____
- Fe_2O_3 - _____

d) prefix sub- [sab-] or **hemi-** [ˈhemi-]

The prefix denotes an oxide in a valence state lower than the common valence state of the element:

element + sub/hemi...oxide

e.g.: Pb_2O – lead suboxide, lead hemioxid

- Cu_2O - _____

e) prefix per- [pə-] or **super-** [ˈsju(:)pə-]

The prefix denotes a peroxide.

e.g. H_2O_2 – hydrogen peroxide

3) Oxides with two different valence states of the element are denoted by combining the names of both oxides:

Fe_3O_4 – ferriferous oxide, ferrosferric oxide

- Ni_3O_4 - _____

B) Acids

1) Acids not containing oxygen atoms are denoted by:

a) affix -ic [-ik] and the word “acid”:

e.g.: HCl – hydrochloric acid; HI – hydroiodic acid

b) or the acidic molecules can be considered compounds with hydrogen and the names are formed as with oxides:

e.g.: HCl – hydrogen chloride; HI – hydrogen iodide

- HF - _____
- HBr - _____
- H₂S - _____

2) Acids containing oxygen atoms: To name the acid, the number of possible acids is decisive:

a) If only one acid can be formed, its name is formed by adding –ic [-ik] to the element

e.g.: H₂CO₃ – carbonic acid

- H₂SiO₃ - _____
- H₃BO₃ - _____

b) If only two acids can be formed, as with oxides, the affix –ous [-əs] denotes the lower valence acid and –ic [-ik] the higher valence acid:

e.g.: HNO₂ – nitrous acid; HNO₃ – nitric acid

- H₂SO₃ - _____
- H₂SO₄ - _____

c) If the given element forms more than two acids, the acid in the lowest valence state combines the prefix hypo- ['haipəu-] with the affix –ous [-əs]; for the highest valence the affix –ic [-ik] and the prefix per- [pə-] are combined:

e.g.: HClO – hypochlorous acid; HClO₂ – chlorous acid; HClO₃ – chloric acid; HClO₄ – perchloric acid

d) Prefixes meta- ['metə-], ortho- ['oθə-, o'θo-], pyro- ['paɪrəu-], thio- ['θaiəu-], hypo- ['haipə-]:

e.g.: HPO₃ – metaphosphoric acid; H₃PO₄ – orthophosphoric acid;

H₄P₂O₇ – pyrophosphoric acid; H₃PO₃S – thiophosphoric acid.

C) Hydroxides

Similar to oxides, the word “hydroxide”, is combined

1) with the unchanged name of the cation if only one hydroxide can be formed:

e.g.: NaOH – sodium hydroxide

- Be(OH)₂ - _____

○ $\text{Al}(\text{OH})_3$ - _____

○ KOH - _____

2) with the name of the element with affixed $-\text{ous}$ [-əs] or $-\text{ic}$ [-ik] to distinguish between the lower and higher valence states, respectively:

e.g.: $\text{Fe}(\text{OH})_2$ – ferrous hydroxide; $\text{Fe}(\text{OH})_3$ – ferric hydroxide

○ $\text{Ni}(\text{OH})_2$ - _____

○ $\text{Ni}(\text{OH})_3$ - _____

D) Salts

1. Salts of acids not containing oxygen atoms: To name the salt, the number of possible salts is decisive:

1) If the cations form a salt in a single valence state, the name is formed as with oxides, i.e. the cation remains unchanged and the name is given by the anion with the affix $-\text{ide}$ [-aid]:

element + anion...ide

e.g.: NaCl – sodium chloride

○ MgBr_2 - _____

○ AgI - _____

○ BN - _____

2) If the cation forms salts in various valence states, then, similar to oxides, the valence state is taken into consideration. It is expressed by:

a) prefixes mono- [ˈmɒnə-, ˈmɒno-, ˈmɒnəu-], di- [dai-], tri- [traɪ-], etc.:

e.g.: FeS – iron monosulphide; FeS_2 – iron disulphide

b) or affixes $-\text{ous}$ [-əs] and, - ic [-ik]

The affix becomes part of the cation name.

e.g.: FeCl_2 – ferrous chloride, FeCl_3 – ferric chloride

c) The valence state of the metal can also be denoted by the Roman numeral:

e.g.: FeCl_3 – iron(III)-chloride

○ NiS - _____

○ CoCl_2 - _____

○ CoCl_3 - _____

2. Salts of acids containing oxygen: The name is formed by starting from the name of the respective acid, and - the affix $-\text{ous}$ [-əs] is replaced by the affix $-\text{ite}$ [-ait] or - the affix $-\text{ic}$ [-ik] by the affix $-\text{ate}$ [-eit], preserving also the respective prefixes hypo- and per-:

e.g.: hypochlorous acid – hypochlorite; chlorous acid – chlorite

e.g.: chloric acid – chlorate; perchloric acid – perchlorate

- KClO_4 - _____
- BaSO_4 - _____
- $\text{Fe}(\text{NO}_3)_3$ - _____
- Na_2SiO_3 - _____
- CdCO_3 - _____

8. Match the chemical formulas of inorganic compounds with their names of traditional chemical nomenclature (1-20), and translations (a-t).

1. AlBr_3	1) Bismuth triiodide	a) Оксид хлора (4)
2. NH_4OH	2) Lead sulphide	b) Хлорид серебра
3. SbCl_5	3) Titanium carbonate	c) Бромид алюминия
4. BiI_3	4) Silicon dioxide	d) Гидроксид лития
5. $\text{Ca}(\text{OH})_2$	5) Cuprous nitrate	e) Пероксид водорода
6. ClO_2	6) Ammonium hydroxide	f) Нитрат меди (1)
7. Cu_2Br_2	7) Carbon dioxide	g) Сульфид свинца
8. H_2O_2	8) Antimony pentachloride	h) Йодид висмута (3)
9. PbS	9) Sulphur dioxide	i) Оксид азота (4)
10. LiOH	10) Chlorine dioxide	j) Оксид кремния
11. N_2O_4	11) Lithium metaphosphate	k) Гидроксид аммония
12. SiO_2	12) Hydrogen peroxide	l) Карбонат титана
13. AgCl	13) Aluminium bromide	m) Гидроксид кальция
14. SO_2	14) Sodium chlorate	n) Оксид серы (4)
15. TiCO_3	15) Calcium hydroxide	o) Оксид углерода (4)
16. LiPO_3	16) Cuprus bromide	p) Хлорид сурьмы (5)
17. CuNO_3	17) Silver chloride	q) Хлорат натрия
18. SnS_2	18) Lithium hydroxide	r) Метафосфат лития
19. CO_2	19) Tin disulphide	s) Дибромид меди (1)
20. NaClO_3	20) Nitrogen tetroxide	t) Сульфид олова (4)

9. Solve a crossword puzzle using the terms of this unit.

A solid-state compound comprising two or more metals exhibiting metallic bonding defined stoichiometry and ordered crystal structure.	↓	←	↑						One of a set of seventeen chemical elements in the periodic table, specifically the fifteen lanthanides, as well as scandium and yttrium.	A nonmetallic halogen element; the poisonous, corrosive dark plates or granules are readily sublimed; insoluble in water, soluble in common solvents; used as a germicide and antiseptic, in dyes, tinctures, and pharmaceuticals, in engraving lithography, and as a catalyst and analytical reagent.
	↓									
	→									
Power of acid to unite with one or more atoms or equivalents of a base, as indicated by the number of replaceable hydrogen atoms contained in the acid.			-							
								↓	←	←
	→									
A halogen element that is isolated as a heavy greenish-yellow diatomic gas of pungent odor and is used especially as a bleach, oxidizing agent, and disinfectant in water purification.	→									
										←
	↑	→								↓
		A bluish gas, very active chemically, and a powerful oxidizing agent, an allotropic form of oxygen-containing three atoms in the molecule, is formed when oxygen or air is subjected to a silent electric discharge.								A chemical compound, a salty-tasting white powder used to preserve meat, and also used in producing explosives and fertilizers.
A nonmetallic chemical element, one of the most reactive of the elements, tasteless, odorless, brittle solid that is pale yellow, a poor conductor of electricity, and insoluble in water.	Having an effect or chemical behavior opposite to an acid.									
	↓	→								
	→	→	→							

10. Put the parts in order to form a sentence.

- 1) **Aluminium**/ post-**transition metals**/ combines/ pre- and/ characteristics of/
- 2) **Ammonia**/ problems/ potential/ with the concomitant/ a fertilizer/ corrosion/ is used as/
- 3) The classical/ to yellow/ azo indicators/ exhibit/ from red/ a color change/ with increasing/ **basicity**/
- 4) **Nitrogen**/ the element/ unreactive/ constitutes/ is comparatively/ triple bond/ in N₂ molecules,/ but as a result/ of the earth's/ atmosphere,/ of the strong/ approximately 78%/
- 5) Iron/ and/ colors/ crystals/ **oxides**/ different/ have/ deferent/
- 6) Atmospheric/ on the surface/ molecules/ are adsorbed/ **oxygen**/ of semiconductor/
- 7) **Ozone**/ and is also/ more toxic/ oxidizing agent/ and corrosive/ is a stronger/ than chlorine/
- 8) **Pyrite**/ metal sulphides,/ other valuable/ precious metals/ associated with/ is commonly/ and with/
- 9) **Sulphur**/ and as/ inorganic **pyrites**/ exists/ in coal/ as organic/ **sulphur** compounds/

11. Reading and discussion

- a) **Read the text and name the advantages of using organocatalysts at room temperature.**

Fabricating the future with a new environment-friendly method of polymerization

Source link: <https://www.sciencedaily.com/releases/2021/02/210224100846.htm>

Date: February 24, 2021

Source: Nagoya Institute of Technology

Summary: The current use of metal catalysts to develop polymers leads to suboptimal quality polymers that contain metallic impurities and involves a reaction process that is not environmentally friendly. Now, scientists have successfully demonstrated the room temperature formation of vinyl and styrene polymers — the two most abundantly found polymers in plastics — using non-ionic, non-metallic organocatalysts, which pave the way for a low cost, environment-friendly, efficient polymer-driven future.

(A) Many materials in the modern world — from the plastics that dominate it to the electronic chips that drive it — are constructed of polymers. Given their ubiquity and the evolving requirements of our world, finding better and more efficient methods of making them is an ongoing research concern. In addition, current environmental issues necessitate the use of methods and input materials that are environmentally friendly.

(B) Recent research by scientists from Nagoya Institute of Technology, Japan, has been in this vein, adding a new twist to a polymerization technique that has been around and

successful since the 1980s: living cationic polymerization, where the polymer chain growth cannot terminate until the monomer is consumed. The scientists have, for the first time, demonstrated metal-free organocatalysis for this reaction at room temperature for vinyl and styrene polymers, two of the most common polymers used in plastics. Their method is not only more efficient than current metal-based methods but also environment friendly.

(C) In their study, they first tested the applicability of non-ionic and multidentate (or several electron-pair accepting) halogen bonding organocatalysts, specifically two iodine-carrying polyfluoro-substituted oligoarenes, to the living cationic polymerization of isobutyl vinyl ether. Mentioning one of their reasons for choosing this, Dr. Koji Takagi, lead scientist in the study, explains in an aside: "The non-ionic characteristic is advantageous because the catalyst is soluble in less polar solvents like toluene which is more suitable for such polymerization of vinyl monomers."

(D) They found that with the tridentate variant, the reaction smoothly progressed even at room temperature, producing good yield — though less than the theoretical limit — in a reasonable amount of time, without the catalyst decomposing or appearing as an impurity in the product. As Dr. Takagi explains, this could be a good advantage over existing metallic catalysts used in industry: "While metal-based catalysts have significantly contributed to the materials sciences over the past century, the contamination of remaining metallic impurities often brings about a decrease in the produced materials' lifetime and performance. We believe that the present finding will lead to the production of highly pure and reliable polymeric materials."

(E) In saying this, he is, of course, referring to the other major finding in the study as well. The second part of their study involved evaluating the applicability of ionic iodoimidazolium catalysts with various counter anions (the negative ions accompanying the positively charged group) to the polymerization of p-methoxystyrene (pMOS) and unsubstituted styrene, the latter of which is more difficult to polymerize than the former.

pMOS easily polymerized at room temperature within two hours and with no catalyst decomposition of a bidentate 2-iodoimidazolium salt that had a triflate counter anion. Unsubstituted styrene gave maximum polymer yield via a reaction at -10°C for 24 hours with an anion-stabilizing and bulky counter ion-containing catalyst.

(F) Speaking of the products yielded, Dr. Takagi says: "Although the obtained polymers are not intended for any specific purpose, our methodology is expected to be applied to the synthesis of conductive polymers and degradable polymers, which should not include metallic impurities if they're to be constructed for practical use."

Indeed, the findings are invaluable for moving forward with the more efficient production of polymeric materials for a variety of applications. However, the successful use

of organocatalysts at room temperature also offers several other advantages. For one, organocatalysts lack sensitivity to moisture and oxygen, taking care of the sometimes serious problem that the relatively hygroscopic nature of ionic catalysts poses to such controlled polymerization reactions. Further, they are readily available and therefore, low cost. They are also not toxic to the environment. And when reactions are conducted at room temperature, the energy requirements are low.

This study is, thus, paving the way for low-cost electronics in the future that are made of environmentally friendly materials in sustainable ways.

b) Choose the best title for each paragraph.

- 1) Selection of suitable catalysts
- 2) Efficient production of polymeric materials for a variety of applications
- 3) Opening more environmentally friendly catalyst
- 4) The perspective of polymeric materials
- 5) Most beneficial applicability
- 6) Polymerization technique

c) Circle the italicized word or phrase to make true statements.

- 1) Scientists have successfully demonstrated the *high/room* temperature formation of vinyl and styrene polymers.
- 2) While *metal-based/metal-free* catalysts have significantly contributed to the materials sciences over the past century, the contamination of remaining impurities often brings about a decrease in the produced materials' lifetime and performance.
- 3) The non-ionic characteristic is advantageous because the catalyst is soluble in *more/less* polar solvents which are more suitable for such polymerization of vinyl monomers.
- 4) The present finding will lead to the production of highly pure and reliable *metal/polymeric* materials.
- 5) This new methodology is expected to be applied to the synthesis of *conductive/non-conductive* polymers and *degradable/non-degradable* polymers, which should not include metallic impurities.

d) Visit one of the websites <https://academic.oup.com/>, <http://abc-chemistry.org/>, <http://www-jmg.ch.cam.ac.uk/data/c2k/cj/> or any other website publishing research articles in Chemistry, choose an article on a topic relevant for your research work, read and summarize its content using the plan and useful phrases in the Appendix. The length of the summary should be about 10 % of the original text.

Unit 3. Organic Chemistry

1. Read the text and say why do we need to study organic compounds and where can organic chemists work.

Organic chemistry is a specific discipline within chemistry that involves the scientific study of the structure, properties, composition, reactions, and preparation of chemical compounds consisting primarily of carbon and hydrogen.

The original definition of this branch of chemistry came from the misconception that organic compounds were always related to life processes. Not all organic compounds support life on Earth, but life as we know it also depends heavily on inorganic chemistry. For example, many enzymes rely on transition metals such as iron and copper; and materials such as shells, teeth, and bones are partly organic and partly inorganic in composition. Apart from elemental carbon, inorganic chemistry deals only with simple carbon compounds, with molecular structures which do not contain carbon to carbon connections (its oxides, acids, carbonates, carbides, and minerals). This does not mean that single-carbon organic compounds do not exist (e.g. methane and its simple derivatives).

Organic compounds are primarily composed of carbon and hydrogen and may contain any number of other elements, the most common of which are nitrogen and oxygen. Each carbon atom, with its pattern of forming four covalent bonds, can connect with other carbon atoms in a variety of ways to give the enormous diversity of organic compounds found. Each molecule is often described as having a "skeleton" of carbon atoms. The essential indication for existence and relationship inherent in four-based structures is appropriate for carbon, one of the bases of life.

Important classes of organic compounds include the alkanes, alkenes, alkynes, aromatic compounds, alcohols, aldehydes, ketones, carboxylic acids, esters, ethers, amines, and amides. Many organic compounds—such as carbohydrates, amino acids, proteins, lipids, nucleotides, and nucleic acids—are found in living systems. The study of organic chemistry has led to enormous benefits in practical terms, such as in the production of textiles, paints, plastics, fuels, and pharmaceuticals.

Because of their unique properties, multi-carbon compounds exhibit an extremely large variety and the range of application of organic compounds is enormous. They are important constituents of many products (paints, plastics, food, explosives, drugs, petrochemicals, etc.) and form the basis of most life processes on our planet.

Trends in organic chemistry include chiral synthesis, green chemistry, microwave chemistry, fullerenes, and microwave spectroscopy.

Organic compounds are all around us. They are central to the economic growth of the United States in the rubber, plastics, fuel, pharmaceutical, cosmetics, detergent, coatings, dyestuff, and agricultural industries, to name a few. The very foundations of biochemistry, biotechnology, and medicine are built on organic compounds and their role in life processes. Many modern, high-tech materials are at least partially composed of organic compounds.

Organic chemistry is a highly creative science in which chemists make new molecules, explore the properties of existing compounds, and developing better ways of synthesizing them.

Organic chemists at all levels are generally employed by pharmaceutical, biotech, chemical, consumer product, and petroleum industries. Chemists in industry mainly work in development, while chemists in academia are involved in more fundamental research. The federal state and local governments also hire organic chemists.

Source links: https://www.newworldencyclopedia.org/entry/Organic_chemistry

https://www.chemeurope.com/en/encyclopedia/Organic_chemistry.html

<https://www.acs.org/content/acs/en/careers/college-to-career/areas-of-chemistry/organic-chemistry.html>

2. Match the terms (1-30), transcriptions (1-30), and translations (a-dd).

1) acetone	1. [ˌkɑːbɒk'sɪlɪk'æsɪd]	a) бензол
2) acetylene	2. [fə:'mældɪhaɪd]	b) электрофил
3) alcohol	3. ['haɪdrəv'kɑːbən]	c) углеводород
4) benzene	4. ['eθənɔ]	d) формальдегид, метаналь
5) benzoic acid	5. ['eθɪlɪ:n'glɑɪkɔ]	e) нафталин
6) carboxylic acid	6. ['prəʊtɪ:n]	f) спирт
7) chloroform	7. ['glɪsərɪn]	g) натуральный каучук
8) electrophile	8. [ə'setɪlɪ(:)n]	h) теломеризация
9) ethanol	9. ['njuːklɪə'faɪl]	i) липид, жир
10) ethylene	10. ['lɪpɪd / 'laɪpɪd]	j) феноло-формальдегидная смола
11) ethylene glycol	11. ['nætʃərəl'gæs]	k) хлороформ, трихлорметан
12) formaldehyde	12. [pə'lmərəɪ'zeɪf(ə)n]	l) пропан

13) glycerine	13. [ˈæsitəʊn]	m) ацетон
14) high-molecular weight compound	14. [ˈfi:nɔl]	n) полимеризация
15) hydrocarbon	15. [ɪˈlektreɪvfaɪl]	o) ацетилен, этин
16) lipid	16. [təˈlɒməraɪˈzeɪf(ə)n]	p) нуклеофил
17) methane	17. [ˈbenzi:n]	q) переэтерификация
18) methanol	18. [ˈælkəhɔl]	r) бензойная кислота
19) naphthalene	19. [ˈklɒrəfɔ:m]	s) глицерин
20) natural gas	20. [ˈhaɪməˈleɪkjələˈweɪtˈkɒmpaʊnd]	t) этиленгликоль, этандиол
21) natural rubber (NR)	21. [ˌterəfˈθæɪkˈæsɪd]	u) терефталевая кислота
22) nucleophile	22. [bənˈzəʊɪkˈæsɪd]	v) карбоновая кислота
23) phenol	23. [ˈmeθənɔl]	w) протеин, белок
24) phenol formaldehyde resin	24. [ˈprəʊpeɪn]	x) этанол
25) polymerization	25. [ˈeθɪli:n]	y) метан
26) propane	26. [ˈnætʃərəlˈrʌbə]	z) природный газ
27) protein	27. [ˌtrænzəˌstərɪfɪˈkeɪʃn]	aa) этилен
28) telomerization	28. [ˈmi:θeɪn]	bb) метанол
29) terephthalic acid	29. [ˈfi:nɔlfɔːˈmædɪhaɪdˈrezɪn]	cc) высокомолекулярное соединение (ВМС)
30) transesterification	30. [ˈnæfθəli:n]	dd) фенол, карбоновая кислота

3. For each definition (1-30) choose a suitable term from task 2 (1-30).

- 1) A simple aliphatic alcohol formally derived from ethane by replacing one hydrogen atom with a hydroxyl group, an important industrial chemical used as a solvent, in the synthesis of other organic chemicals, and as an additive to gasoline.
- 2) An organic chemical compound composed only of the elements carbon (C) and hydrogen (H).

- 3) A light volatile flammable poisonous liquid alcohol; used as an antifreeze and solvent and fuel and as a denaturant for ethyl alcohol.
- 4) An aromatic organic compound with the formula C_6H_5OH . The molecule consists of a phenyl group bonded to a hydroxyl group. A white crystalline volatile soluble poisonous acidic derivative of benzene, used as an antiseptic and disinfectant and in the manufacture of resins, nylon, dyes, explosives, and pharmaceuticals.
- 5) A process of reacting monomer molecules together in a chemical reaction to form polymer chains or three-dimensional networks.
- 6) The reaction of an ester with an alcohol to replace the alkoxy group that is used in the synthesis of polyesters and the production of biodiesel.
- 7) A high-molecular-weight polymer compound, large biomolecule, or macromolecule, composed of a variety of alfa-amino acids joined by peptide linkages.
- 8) One of a class of compounds that contain long-chain aliphatic hydrocarbons and their derivatives, such as fatty acids, alcohols, amines, amino alcohols, and aldehydes; includes waxes, fats, and derived compounds.
- 9) A simple polyol compound, a colorless, odorless, viscous liquid that is sweet-tasting and non-toxic.
- 10) The simplest alkene, and the simplest unsaturated hydrocarbon after acetylene with the formula C_2H_4 , a colorless flammable gas with a faint "sweet and musky" odor when pure, used in the chemical industry, and its worldwide production exceeds that of any other organic compound.
- 11) An organic acid that contains a carboxyl group ($C(=O)OH$) attached to an R-group.
- 12) The simplest ketone; an organic compound with the formula $(CH_3)_2CO$, a colorless, highly volatile, and flammable liquid with a characteristic pungent odor, miscible with water, and widely used as an organic solvent and as material for making plastics.
- 13) A white crystalline organic acid; the simplest aromatic carboxylic acid; used as a food preservative, precursor to plasticizers, and in many other industrial applications.
- 14) A naturally occurring organic compound, the simplest aldehyde with the formula $H-CHO$, a colorless pungent-smelling gas that dissolves in water to give formalin and has many industrial applications.
- 15) The simplest aliphatic hydrocarbon, CH_4 , being a constituent of natural gas. A colourless, odourless, and tasteless gas, lighter than air and reacting violently with chlorine and bromine in sunlight, a chief component of natural gas; used as a source of methanol, acetylene, and carbon monoxide.
- 16) Any of a number of synthetic resins made by reacting phenol (an aromatic alcohol derived from benzene) with formaldehyde (a reactive gas derived from methane).

- 17) The organic compound with formula $C_6H_4(COOH)_2$, a colorless solid substance used principally as a precursor to the polyester PET, used to make clothing and plastic bottles.
- 18) An atom or molecule that in chemical reaction seeks a positive center, such as the nucleus of an atom, because of containing an electron pair available for bonding.
- 19) A gas consisting mainly of methane, a simple hydrocarbon gas, a fossil fuel that is derived from chemical and physical processes operating on buried ocean plankton.
- 20) An organic or inorganic, amorphous, or crystalline substance that has a high molecular weight (from 100 g/mol), a polymer, i. e. monomeric substances that do not change their mass when the same "heavy" substance is attached to them.
- 21) A sweet poisonous syrupy liquid, the simplest member of the glycol family of organic compounds, is commonly used as an antifreeze in automobiles as, a raw material in the manufacture of polyester fibers and solvent.
- 22) An organic chemical compound with the molecular formula C_6H_6 , an aromatic hydrocarbon, a cyclic hydrocarbon with a continuous pi bond, a natural constituent of crude oil, and is one of the most elementary petrochemicals, a colorless, liquid, flammable, aromatic hydrocarbon used to manufacture styrene and phenol.
- 23) The simplest alkyne, a hydrocarbon of formula C_2H_2 , a colorless gas, with a peculiar, unpleasant odor used in welding or metallurgy.
- 24) An elastic substance obtained from the exudations of certain tropical plants consists of polymers of the organic compound isoprene, with minor impurities of other organic compounds, plus water.
- 25) A white crystalline the simplest polycyclic aromatic hydrocarbon, $C_{10}H_8$, analogous to benzene, and obtained by the distillation of certain bituminous materials, such as the heavy oil of coal tar.
- 26) A chemical species that forms bonds with nucleophiles by accepting an electron pair, most of which are positively charged, have an atom that carries a partial positive charge or have an atom that does not have an octet of electrons.
- 27) A colorless, easily liquefied, aliphatic gaseous hydrocarbon (C_3H_8), a constituent of natural gas, the third member of the paraffin series following methane and ethane.
- 28) A radical polymerization reaction where a chain transfer limits the size of the oligomer molecule product—the telomer.
- 29) A colorless, volatile, strong-smelling, dense liquid, one of the four chloromethanes and a trihalomethane, that is produced on a large scale as a precursor to PTFE and various refrigerants, a powerful anesthetic, euphoriant, anxiolytic, and sedative when inhaled or ingested.
- 30) A group of organic chemical compounds composed of carbon, hydrogen, and oxygen, where the molecules in the series vary in chain length and are composed of a hydrocarbon plus a hydroxyl group.

4. Fill in the gaps using the terms studied in this unit (task 2). In some sentences the plural form is required. In each paragraph, the same word is missing.

1) _____ are compounds comprised exclusively of carbon and hydrogen and they are by far the dominant components of crude oil, processed petroleum _____ (gasoline, diesel, kerosene, fuel oil, and lubricating oil), coal tar, creosote, dyestuff, and pyrolysis waste products. _____ exist widely in living organisms and are particularly prevalent in geological deposits of biological origin. The structures of some _____ in geological deposits can be related to functionalized precursors in the source material.

2) _____ is an alternative to liquid fuels in a variety of applications, ranging from metal welding, home heating to vehicular fuel. _____ is the predominant component of most natural and industrial hydrocarbon gases and, therefore, it is not surprising that the vast majority of studies on the partial oxidation of hydrocarbon gases have dealt with the oxidation of _____, all the more that the conversion of this most stable alkane is a major technological challenge. However, almost all hydrocarbon gases contain admixtures of heavier homologs of _____, even small concentrations of which have a marked effect on the kinetics of its oxidative conversion.

3) In chemical compounds, _____ can occur via a variety of reaction mechanisms that vary in complexity due to the functional groups present in the reactants and their inherent steric effects. In more straightforward _____, alkenes form polymers through relatively simple radical reactions; in contrast, reactions involving substitution at a carbonyl group require more complex synthesis due to the way in which reactants polymerize. Alkanes can also be polymerized, but only with the help of strong acids. _____ reactions can be further classified into the batch and continuous processes. Continuous operation is feasible for the production of large quantities of polymers with uniform properties.

4) _____ is a renewable fuel that is widely distributed in many countries, especially in Brazil, which makes _____ a potential candidate for use in fuel cell devices without reforming. _____ obtained from distillation contains about 95% _____, which is usually enough for applications in the pharmaceutical, cosmetic, solvent, and chemical industries. Distillation is not able to provide a higher concentration of _____ due to its azeotrope point with water. However, for blending with gasoline, _____ must have at least 99.2% purity, which is obtained by dehydration or drying of the _____ after the distillation.

5) Among possible additives, _____ are commonly used. However, the effectiveness is limited and few studies have been conducted to understand the effects of the molecular structure of _____ on the hydrate decomposition. Here, with the aid of molecular dynamic simulations, we systematically investigate the effects of chain length, hydroxyl position, and a hydroxyl number of _____ on the decomposition of methane

hydrates. Combining variations of potential energy, radial distribution functions, and mean square displacement, the influences of _____ structural properties on the hydrate decomposition are evaluated.

6) The conversion of CO₂ into _____ is a technical challenge. Commercial copper-zinc-alumina catalysts convert a maximum of 7% carbon dioxide in syngas at high pressures (5 MPa to 10 MPa) and moderate temperatures (473 K to 573 K) into _____. However, there are no records on the synthesis of _____ at low pressure (P<2,5 MPa) and without a large excess of hydrogen in the feed. Here, we tested three new catalysts prepared by co-precipitation of copper, zinc, and aluminum nitrates (CZA), with strontium, magnesium, or calcium as basic promoters to enhance CO₂ conversion to _____.

7) _____ are compounds that possess a hydroxyl group directly attached to an aromatic carbocyclic nucleus. _____ is the trivial name for monohydroxybenzene. Simple monohydric _____ are either corrosive liquids or low melting solids. The dihydric and trihydric _____ are solids. _____ and the cresols are widely used as antiseptics and disinfectants; the cresols are contained in the wood preserving fluid, creosote. Many _____ have wide application in the industrial production of plastics, dye-stuffs, insecticides, selective weedkillers, and germicides.

8) _____ is composed of methane, ethane, propane, carbon dioxide, nitrogen, hydrogen, carbon monoxide, and unknown alkane components of C₄ or more (denoted as C₄₊) after desulfurization and dehydration treatment. The concentrations of the first seven components account for more than 90% of _____. When analyzing the _____ composition using Raman spectral analysis methods, a small number of unknown alkane components C₄₊ will harm the analytical precision. _____ reserves are increasing more rapidly than those of petroleum, and it is anticipated that this trend will extend well into the 21st century.

9) _____ is sometimes considered as the “king of petrochemicals,” because there are more commercial chemicals produced from _____ than from any other intermediate due to _____’s several favorable properties as well as other technical and economic factors. _____ is a relatively inexpensive compound, which can be easily produced from any hydrocarbon source through refinery processes like steam-cracking. Furthermore, there are fewer by-products generated from _____ reactions with other compounds than from other olefins.

10) _____ is an important organic chemical compound with the chemical formula C₆H₆ and its molecule is composed of 6 carbon atoms joined in a ring with 1 hydrogen atom attached to each carbon atom. _____ is a volatile aromatic hydrocarbon that is widespread in the ecosystem due to the burning of fuels and leakage or spillage of petroleum fuels. _____ has six molecular orbitals that form a delocalized π system;

three of _____'s molecular orbitals are bonding and each has two electrons; three are antibonding, and they are vacant.

11) _____ is a dihydroxy alcohol derivative of ethane that is toxic to animals and can induce tissue damage and chronic renal failure. _____ is found in automobile antifreeze (major use) and hydraulic brake fluid. A major commercial application of _____ is deicing fluid for aircraft. _____ is not volatile, and the risk of inhalation exposure is minimal. _____ is very toxic, and ingestion may cause death. However, occupational exposure to _____ is not a health hazard as long as _____ does not come in contact with skin because it is absorbed from the skin.

12) _____ is a specific organic compound: a polynuclear aromatic hydrocarbon of formula $C_{10}H_8$ with a chemical structure that can be envisioned as two benzene rings fused. The hydrocarbons _____, anthracene, and phenanthrene represent the simplest examples of a series of polynuclear hydrocarbons in which benzene rings are condensed or fused so that neighboring rings share a pair of adjacent carbon atoms. Electrophilic substitution in _____ proceeds more readily than in the case of benzene. With _____, the charged intermediates involved retain a considerable degree of resonance stabilization because of the presence of the intact benzene system, whereas during substitutions in benzene, the formation of the charged intermediate results in the resonance stabilization being largely destroyed.

13) _____ are mainly used in the production of circuit boards. They are better known however for the production of molded products including pool balls, laboratory countertops, and coatings and adhesives. In the form of Bakelite, they are the earliest commercial synthetic resin. _____ are formed from the specific reactions of phenol with formaldehyde, whereas the definition of phenolic resins includes the reaction of phenol with other aldehydes as well. Most of the phenolic resins used for the treatment of filter paper are of the phenol-formaldehyde form; however, there are some variations.

14) _____ involves a telogen or a transfer agent (X–Y), and one or more (n) molecules of a polymerizable compound M (called taxogen or monomer), under radical polymerization conditions, leading to X–(M)_n–Y telomers. _____ reactions, in contrast to polymerization reactions, are generally regarded as reactions that lead to oligomers having very low molecular weights and even mono addition compounds. For the first time, in 1946, Handford¹ defined _____ as the reaction between a compound XY called the telogen and one or several molecules of a polymerizable species M called the taxogen, under polymerization conditions. _____ leads to the formation of telomers.

15) _____ is a common name of 1,2,3-propanetriol, a compound naturally present in form of fatty acid esters (triglycerides). However, for industrial use in the past, the main source used for the preparation of _____ was not sustainable. _____ was mainly

prepared from a petroleum-derived product, propene. Only limited quantities of _____ was produced from renewable sources in soap manufacture and fatty acid production. Nowadays, the exponential growth in the production of biodiesel has completely changed this situation. In the production of biodiesel, _____ is the main co-product. Production of one ton of biodiesel generates about 110 kg of crude _____ or about 100 kg of pure _____. From nearly two million tons of _____ produced annually, only 20% are now petroleum-derived.

16) _____ are traditionally (and in the simplest way) defined as apolar compounds that are insoluble in water, and consequently, can be enriched by extraction with organic solvents, such as chloroform or hexane. The extraction of _____ from a given body fluid, cell culture, or tissue sample, therefore, is normally the first step of _____ analysis. Despite its central role, _____ extraction does not engender major interest! _____ are the major source of amphiphilic structures within the cells that contain a polar head group linked to a hydrophobic hydrocarbon chain.

17) The chemistry of _____ is the study of molecular chains consisting of monomeric subunits. _____ can be synthesized from monomer(s) and/or low molecular weight prepolymers. In low molecular weight polymers, the glass transition increases with increasing molecular weight. For amorphous polymers, molecular weight has also a large effect on the dynamic mechanical behavior above the glass transition region. _____ chains are long enough to temporarily become entangled with each other, thereby forming physical crosslinks.

18) _____ occurs naturally in many plants and serves as an intermediate in the biosynthesis of many secondary metabolites. Salts of _____ are used as food preservatives. _____ is an important precursor for the industrial synthesis of many other organic substances. _____ is produced commercially by partial oxidation of toluene with oxygen. The process is catalyzed by cobalt or manganese naphthenates. The process uses abundant materials and proceeds in a high yield. The first industrial process involved the reaction of benzotrichloride with calcium hydroxide in water, using iron or iron salts as a catalyst. The resulting calcium benzoate is converted to _____ with hydrochloric acid. The product contains significant amounts of chlorinated _____ derivatives. For this reason, _____ for human consumption was obtained by dry distillation of gum benzoin. Food-grade _____ is now produced synthetically.

19) _____ is an important chemical commodity that, amongst other uses, serves as a source of acrylic acid to manufacture acrylic fibers, glasses, paints, resins, and polymers. _____ groups in linear polymers are characterized by a unique set of properties including electrical conductivity and nonlinear optical properties. One route to incorporate _____ groups into the polymer backbone is through oxidative coupling in the presence of a metal catalyst. _____ is converted into vinylsilane under appropriate hydrosilylation conditions with a Pt, Rh, Ru, or Al catalyst.

20) _____ are the most widely used ligands to construct the coordination polymers including the acentric infinite coordination nets for use as NLO (second-order nonlinear optical) materials. _____ dissolve in common alcohol solvents such as ethanol. This solubility results from intermolecular hydrogen bonds between solute and solvent, and van der Waals attractions between the ethyl group of ethanol and the nonpolar tail of the _____. Nonpolar solvents, such as chloroform, are also excellent solvents for _____. In these solvents, the _____ exist as relatively nonpolar hydrogen-bonded dimers that are compatible with the solvent.

21) _____ is a gas with a boiling point of -21°C . It is usually supplied as a stabilized aqueous solution ($\sim 40\%$ _____) known as formalin. _____ is by far the most commonly employed aldehyde in the manufacture of phenolic resins. It is normally used as an aqueous solution, known as formalin, containing about 37% by weight of _____. From 0.5–10% of methanol may be present to stabilize the solution and retard the formation of polymers. When the formalin is used soon after manufacture, only low methanol contents are employed since the formalin has a higher reactivity. Where a greater storage life is required the formalin employed has a higher methanol content, but the resulting increasing stability is at the expense of reduced reactivity.

22) The reactivity of quinones towards _____ is dependent to a large degree on the π -acceptor character and electron affinity of the quinones. A carboxylic acid in the active site acts as the catalytic _____ in the formation of the covalent intermediate while a second carboxylic acid acts as a general acid catalyst. Dithiocarbamic acids and thiols are employed in the Bargellini reaction to generate useful intermediates for the synthesis of organic molecules. This is the first time that dithiocarbamate acids are used as _____ in this reaction.

23) _____ is the displacement of alcohol from an ester by another one in a process similar to hydrolysis, except that alcohol, is used instead of water. _____ is one of the reversible reactions and proceeds essentially by mixing the reactants. However, the presence of a catalyst (strong acid or base) accelerates the conversion and a little excess of alcohol is used to shift the equilibrium toward the formation of fatty acid alkyl esters and glycerol. _____, catalyzed by the heterogeneous catalyst is a more complex reaction (reaction proceed on the surface of solid catalyst) since it is a three-phase liquid-liquid-solid reaction.

24) _____ is a fuel largely used by the residential-commercial-automotive (65%) and less by the industrial (30%) sectors in Western Europe. The efficiency of _____ as fuel is high compared to other traditional fuels and substantial environmental gain is assumed, especially when used by the final user directly without being converted into electricity. _____ oxidation was investigated over $\text{Pd}/\text{Al}_2\text{O}_3$ and $\text{Pd}/\text{CeO}_2/\text{Al}_2\text{O}_3$

catalysts. In fuel-rich conditions, the results pointed us to two discrete domains of reaction: oxidation in low temperatures (< 20% of _____ conversion) and steam reforming of _____ after oxygen has disappeared.

25) _____ are electron-deficient species that are attracted to an electron-rich center. _____ react by accepting an electron pair to form a bond to a nucleophile including the interactions of a proton and a base. _____ are often positively charged as a result of possessing an atom with a positive charge or an atom that does not have an octet of electrons. _____ derived from xenobiotics can react with biological nucleophiles on macromolecules to covalently modify them and cause toxicity.

26) _____ is an industrial and laboratory solvent and a chemical precursor for other materials. Its chemical names are dimethyl ketone and 2-propanone. _____ is used in the production of pharmaceuticals and cosmetics. _____ is produced in nature by forest fires, trees and plants, and volcano eruptions; our body naturally makes _____ in the process of breaking down fat. _____ as a pollutant is released into the environment as part of automobile exhaust, emissions, and discharges from chemical manufacturing and other industries, and landfill leachates. The main transport modes for _____ are volatilization from soil and water and leaching from soil to water.

27) _____ is the most popular solvent, although carbon tetrachloride, benzene, toluene, and isoamyl acetate are also used. _____ is used as an industrial solvent and as an intermediate in the manufacture of polymeric materials. The major use of _____ today is in the production of the refrigerant R-22, commonly used in the air conditioning business. In industrial production, _____ is produced by heating a mixture of chlorine and either chloromethane (CH_3Cl) or methane (CH_4). The output of this process is a mixture of the four chloromethanes (chloromethane, dichloromethane, _____, and carbon tetrachloride), which can then be separated by distillation. _____ may also be produced on a small scale via the haloform reaction between acetone and sodium hypochlorite.

28) _____ are large size molecules (macromolecules), polymers of structural units called amino acids. A total of 20 different amino acids exist in _____ and hundreds to thousands of these amino acids are attached in long chains to form a _____. Amino acids can be released from _____ by hydrolysis. _____ earned their primary responsibility in cellular function even before DNA. _____ are the most complex of all biological molecules in terms of their structures and functions. No place in a cell functions without _____.

29) _____ is an isoprene polymer that has a high molecular weight. Hevea rubber derived from the Hevea Brasiliensis tree is a natural form of 1,4 - polyisoprene. _____ is one of the most useful materials in engineering applications. The preparation method for _____ compounds uses Open Mill by mixing Indonesian Rubber Standard-20 (SIR-20) with anti-oxidants, activators, preservatives, accelerators, and

OPBA nanoparticle fillers. Generally, _____ which has a non-polar chain is modified first, so that compatibility and reactivity of _____ are increased in mixing. The rubber modification method that has been used is halogenation.

30) _____ is one of the major starting materials for polyester production that has a diverse range of uses for materials and high-performance products as well as consumer products related to clothing and containers with poly(ethylene terephthalate) bottles or PET bottles being a familiar example. _____, a raw material for polyethylene terephthalate (PET) production, is one of the most important chemicals in the petrochemical industry. _____ is an important raw material for the production of polyethylene terephthalate (PET). It is usually obtained by the catalytic oxidation of p-xylene in air, in the presence of acetic acid (HAc) as solvent.

5. Put the parts in order to form a sentence.

- 1) Liquefaction/ of **natural gas**/ in long/ processes/ plays/ an important/ distances/ role/ for transmission/
- 2) The contamination/ petroleum/ the environment/ but also/ can endanger/ humans/ generated by/ **hydrocarbons**/ not only/
- 3) **Acetylene** (C_2H_2)/ welding/ for gas/ fuel gas/ is the main/
- 4) The main/ manufacturing/ exhaust/ are automobile/ of **benzene**/ sources/ emissions/ to the atmosphere/ and chemical/
- 5) **Phenols**/ properties/ classified/ unique/ and are not/ as alcohols/ have/
- 6) **Chloroform**/ slowly/ releasing HCl/ converts/ in the process/ to phosgene ($COCl_2$),/ in air/
- 7) An aqueous/ is called/ all cases/ and in almost/ of **formaldehyde**/ formalin/ is used/ solution/ industrially/ formalin,/
- 8) **Naphthalene**/ more readily/ addition/ reactions/ than **benzene**/ also undergoes/

6. Translate the sentences into Russian. The words in bold should be taken from the unit's list of terms.

- 1) **Methane**, which is the principal component of **natural gas** reserves, is currently being used for home and industrial heating and for the generation of electrical power.
- 2) Conventional distillation is used to concentrate **ethanol** in a near-azeotropic mixture (hydrous ethanol, which is about 95% ethanol and 5% water).
- 3) Higher **alcohols** (**alcohols** with **higher molecular weight** than **ethanol**) are more compatible for existing fuel distribution infrastructures than **ethanol**.
- 4) **Benzene** is mainly produced by catalytic reforming, hydrodealkylation of toluene, and steam cracking.

- 5) **Propane** pyrolysis plays an important industrial role, mainly in the synthesis of propene, which is used, for example, for producing polypropylene.
- 6) **Ethylene** used for the production of polyethylene is a chemical monomer obtained by steam cracking gaseous feedstocks (ethane, propane, or butane) or liquid feedstocks (naphtha or gas oil).
- 7) **Benzoic acid** is a colorless crystal solid that can reduce the energy of the surface in a reaction.
- 8) **Phenol** is a highly toxic compound causing **protein** degradation and tissue erosion.

7. Study the nomenclature of organic chemical compounds and fill in the gaps in the table in task 8. Materials are taken from <https://studyres.com/doc/15711245/chemistry>

Naming organic compounds

There are trivial and systematic names of organic compounds. Trivial names (such as acetone, toluene) have their origin in history or nature. IUPAC takes care of a systematic nomenclature system in chemistry.

Systematic names are built up by joining syllables according to the following rules:

- a) A **syllable** is used to denote **the number of carbon atoms** in the longest straight unbranched carbon chain in the compound. The number of carbon atoms thus formulates a saturated hydrocarbon (having only single bonds between carbon atoms) and the specific compound is regarded as a substituted hydrocarbon (using prefixes of functional groups, double bonds, etc.). The longest straight carbon chain can be found by following the occurrences of carbon in the formula.

The systematic syllables are:

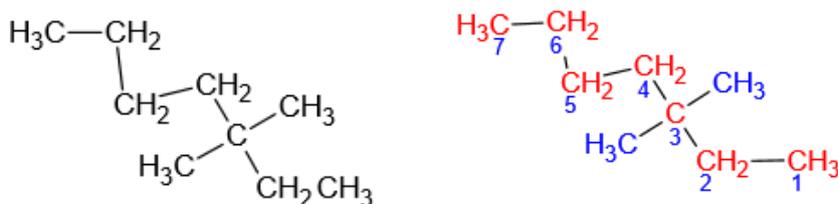
Number of Carbon Atoms	Syllable (Saturated Hydrocarbon)	Number of Carbon Atoms	Syllable (Saturated Hydrocarbon)
1	meth(ane)	6	hex(ane)
2	eth(ane)	7	hept(ane)
3	prop(ane)	8	oct(ane)
4	but(ane)	9	non(ane)
5	pent(ane)	10	dec(ane)

An ending is used to indicate the type of bond between the carbon atoms:

Type of Bonds	Ending	Example
Single bonds	-ane	methane, ethane
Double bond	-ene	ethene, propene
Triple bond	-yne	ethyne, propyne

In one compound there can be more double or triple bonds.

Example:



We have found the longest unbranched carbon chain (highlighted by red colour and marked by numbers 1 – 7). The number of carbon atoms is seven; therefore, the name of the compound will be derived from heptane. All bonds in our compound are single bonds; therefore, the ending “-ane” in heptane is correct.

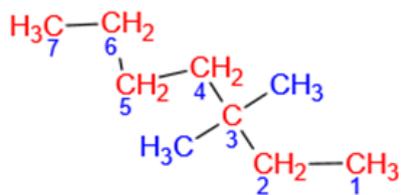
Note: When the terminal ending (ex. “diene”) starts with a consonant, there is “-a” at the end of the hydrocarbon name (hepta). Because the terminal ending (“-ene”) starts with a vowel, we do not have to add “-a” at the end of the hydrocarbon name.

The carbon atoms in the longest unbranched carbon chain are numbered by Arabic numerals. The numbers are placed so as to have the smallest number where the chain is branched (blue groups in our compound, carbon atom number 3). These two –CH₃ groups are called functional groups.

b) A syllable (prefix or ending) is used to indicate a functional group:

Formula of a Functional Group	Functional Group Name	Prefix	Ending	Example	
-C _n H _{2n+1}	alkyl group	-	-yl	-C ₂ H ₅	-ethyl
-OH	alcohol	hydroxy-	-ol	C ₂ H ₅ OH	ethanol
-CHO	aldehyde	aldehyde-	-al		2-hydroxypropanoic acid
=CO	ketone		-one	CH ₃ COCH ₃	propanone
-Cl	chloride	chloro-	-	C ₂ H ₅ Cl	chloroethane
-NH ₂	amino	amino-	-	CH ₃ NH ₂	aminomethane
-NO ₂	nitro	nitro-	-	C ₆ H ₅ NO ₂	nitrobenzene
-COOH	carboxylic acid	-	-oic acid / carboxylic acid	CH ₃ COOH	ethanoic acid

Example:

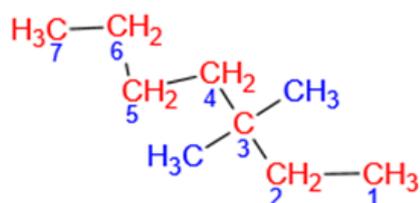


There are two methyl groups (functional groups) in position 3. Compounds with the same molecular formula but different structure (e.g. different position of functional groups) are called isomers. Therefore, it is important to mark the position of the functional group. Isomers usually have different chemical or physical properties.

c) **Greek prefixes** are used to indicate the number of the same functional group(s), except for the monosubstituted compound.

Number of Groups	Prefix	Number of Groups	Prefix
1	mono-	6	hexa-
2	di-	7	hepta-
3	tri-	8	octa-
4	tetra-	9	nona-
5	penta-	10	deca-

Example:



There are two methyl groups in the compound; therefore, the prefix is “di-” - dimethylheptane. As has already been shown, Arabic numerals are used to denote the carbon atoms in the carbon chain to which functional groups are bonded. We know that two functional groups are in position 3; therefore, the name of the compound is 3,3-dimethylheptane.

d) **Aromatic compounds** without side chains have benzene as the root with the already mentioned prefixes and suffixes to indicate functional groups. The selected examples are in the following table:

Overview of hydrocarbons and derivatives of hydrocarbons

Table 1. Hydrocarbons

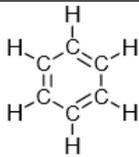
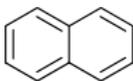
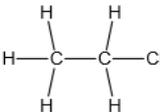
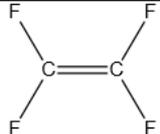
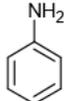
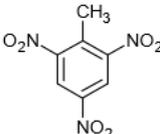
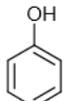
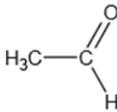
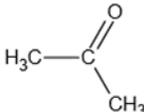
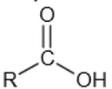
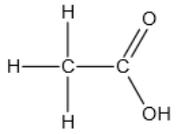
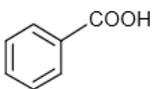
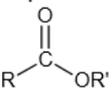
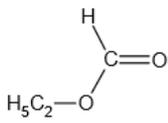
Group Name	Group Characteristics	Selected Representatives		
		Name	Formula	Properties
Alkanes	Only single bonds between carbon atoms (General formula C_nH_{2n+2})	methane	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	the simplest alkane; main component of natural gas
		octane	C_8H_{18}	very flammable; a component of gasoline (petrol)
Cycloalkanes	Cyclic alkanes (General formula C_nH_{2n})	cyclohexane		can have different conformations – chair or boat ones
Alkenes	At least one double bond between carbon atoms (General formula C_nH_{2n})	ethene (ethylene)	C_2H_4	the simplest alkene; a plant hormone (causes ripening of fruits)
Alkynes	At least one triple bond between carbon atoms (General formula C_nH_{2n-2})	ethyne (acetylene)	$\text{H}-\text{C}\equiv\text{C}-\text{H}$	a linear symmetrical molecule; colourless gas; the simplest alkyne
Arenes (aromatic hydrocarbons)	Hydrocarbons with alternating double and single bonds between carbon atoms forming ring(s)	benzene		planar structure; carcinogenic; liquid with a sweet smell
		naphthalene		polycyclic aromatic hydrocarbon; white crystalline solid

Table 2. Derivatives of Hydrocarbons

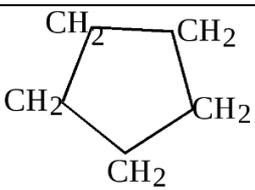
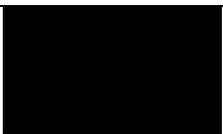
Group Name	Group Characteristics	Selected Representatives		
		Name	Formula	Properties
Haloalkanes (halogenoalkanes, alkyl halides)	Containing one or more halogens (F, Cl, Br, I)	chloroethane (ethyl chloride)		used as a local anesthetic in sports
		tetrafluoroethylene		polytetrafluoroethylene (PTFE) - produced by its polymerization; also known as Teflon or Gore-Tex
Amines	Containing an amino functional group -NH ₂	aniline		toxic organic compound with formula C ₆ H ₅ NH ₂ , used in dye industry
Nitro compounds	Containing a nitro functional group -NO ₂	TNT (trinitrotoluene)		yellow-coloured solid; explosive material
Alcohols	Containing a hydroxyl functional group -OH	methanol	CH ₃ OH	also known as wood alcohol; used to be produced as a byproduct of distillation of wood
		ethanol	C ₂ H ₅ OH	alcohol found in alcoholic beverages, produced by fermentation of sugars
Phenols (phenolics)	Containing a hydroxyl group bonded directly to an arene	phenol		crystalline volatile solid; an important industrial precursor to many materials

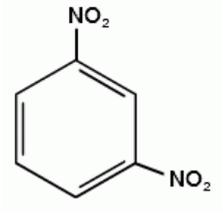
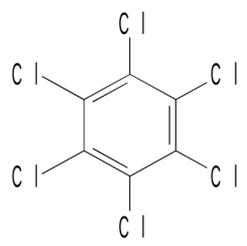
Ethers	Containing an oxygen atom connected to two alkyl or aryl groups R-O-R	dimethyl ether	CH ₃ -O-CH ₃	the isomer of ethanol; colourless gas
Aldehydes	Containing an aldehyde functional group -CHO 	acetaldehyde (ethanal)		occurs naturally in coffee, bread, and ripe fruit
Ketones	Containing a carbonyl functional group R-CO-R' 	acetone (propanone)		important solvent; used also for cleaning purposes in laboratories

Carboxylic acids	Containing a carboxyl functional group -COOH 	methanoic acid (formic)	HCOOH	contained in insect stings and nettles
		ethanoic acid (acetic)		part of vinegar
		butanoic acid (butyric)	$\text{CH}_3(\text{CH}_2)_2\text{COOH}$ H	unpleasant smell and acid taste; present in rotten butter
		benzoic acid		an aromatic carboxylic acid
Esters	Containing a functional group RCOOR' 	ethyl formate		rum odour (odorant)

Notes: R and R' represent a hydrogen atom (-H) or alkyl group (e.g. methyl -CH₃, ethyl -C₂H₅, etc.)

8. Complete the table with chemical formulas, systematic and/or trivial names of the substances, and Russian equivalents of the terms.

Chemical formula	Name	Russian equivalent
	Cyclopentane	Циклопентан
	Dichloromethane	Дихлорметан
	Propan-2-ol	
		

Chemical formula	Name	Russian equivalent
		Диметилловый эфир
		
	N-butyl acetate	
		Формальдегид
$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}\equiv\text{C}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$		
	Dimethyl sulphate	
		
		Аминбензол/Анилин
	Methylbenzene/Toluene	
$\text{H}_3\text{C}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3$		
		Этилбензол
		Винилбензол/ Стирол

9. Translate the sentences into English. The words in bold should be taken from the unit's list of terms.

- 1) Существует два типа резины, обычно используемых в промышленности, которые являются **натуральным каучуком** и синтетическим каучуком.
- 2) **Бензол** участвует в синтезе этилбензола, который, в свою очередь, дегидрируется до стирола.
- 3) **Ацетон** является наиболее часто используемым растворителем, который способствует осаждению **белка** и одновременно растворяет неполярные молекулы, такие как **липиды**.
- 4) **Карбоновые кислоты** с низкой молекулярной массой растворяются в воде, потому что карбоксильная группа образует несколько водородных связей с водой.
- 5) **Формальдегид** получают путем контролируемого каталитического окисления метилового спирта (**метанола**).
- 6) **Бензойная кислота** может быть очищена перекристаллизацией из воды из-за ее высокой растворимости в горячей воде и плохой растворимости в холодной воде.
- 7) **Липиды**, погруженные в воду, образуют различные типы агрегатов, в зависимости от типа **липидов**.
- 8) Каталитическое окисление п-ксилола, приводящее к образованию **терефталевой кислоты**, является хорошо известным процессом, широко используемым в нефтехимической промышленности.

10. Find 20 hidden terms in the word search puzzle. The terms are directed forward →, back ←, down ↓, up ↑ and diagonally ↘, ↙, ↖, ↗. There are terms made up of one, two, or more words. The words do not belong together, but they are fused in the puzzle. One of the terms is marked.

t	p	f	d	e	s	c	n	e	n	i	r	e	c	y	l	g
b	o	r	f	l	a	l	c	o	h	o	l	k	y	t	k	x
l	e	i	o	o	y	s	a	g	l	a	r	u	t	a	n	e
p	v	n	t	t	r	u	k	f	r	m	b	r	c	r	n	l
a	a	z	z	a	e	m	b	y	a	s	e	l	l	h	u	i
v	c	g	c	e	z	i	a	d	c	b	v	i	o	f	c	h
l	p	e	k	t	n	i	n	l	b	f	n	p	n	t	l	p
o	r	z	t	f	k	e	r	u	d	o	y	i	a	l	e	o
n	o	s	d	y	t	a	r	e	b	e	h	d	h	j	o	r
a	p	h	r	w	l	l	c	r	m	k	h	m	t	h	p	t
h	a	f	h	v	a	e	a	e	t	y	l	y	e	t	h	c
t	n	y	m	r	y	c	n	n	t	p	l	o	d	v	i	e
e	e	e	u	k	o	k	a	e	g	o	r	o	n	e	l	l
m	r	t	b	r	q	a	s	s	h	k	n	c	p	e	e	e
z	a	l	d	a	m	e	t	h	a	n	e	e	k	n	h	v
n	o	y	w	e	m	r	o	f	o	r	o	l	h	c	b	p
h	h	e	t	h	y	l	e	n	e	g	l	y	c	o	l	t

11. Reading and discussion.

a) Read the text and say what the term *autoxidation* means and which processes are caused by autoxidation.

Oxidation processes in combustion engines and the atmosphere take the same routes. Efficient autoxidation chain reactions demonstrated for the substance group of saturated hydrocarbons

Source link: <https://www.sciencedaily.com/releases/2021/02/210223164440.htm>

Date: February 23, 2021

Source: Leibniz Institute for Tropospheric Research (TROPOS)

Alkanes, an important component of fuels for combustion engines and an important class of urban trace gases, react via other reaction pathways than previously thought. These hydrocarbons, formerly called paraffins, produce large amounts of highly oxygenated compounds that can contribute to organic aerosol and thus to air pollution in cities. An international research team has now been able to prove this through laboratory experiments with state-of-the-art measurement technology at the University of Helsinki and the Leibniz Institute for Tropospheric Research (TROPOS) in Leipzig.

The results of this interdisciplinary work provide crucial information about oxidation processes both in combustion engines and in the atmosphere -- with direct implications for engine efficiency and the formation of aerosols, especially in cities, the research team writes in the journal *Communications Chemistry*, an open-access journal published by the Springer-Nature publishing group.

Oxidation processes play a major role both in the atmosphere and in combustion. A chain reaction called autoxidation is enabled by high engine temperatures. But it also acts as an important source of highly oxygenated compounds in the atmosphere that form an organic aerosol, as researchers from Finland, Germany, and the USA demonstrated in 2014. Autoxidation is one reason for the aging processes of organic compounds by oxygen from the air. It contributes to the spoilage of food and wine.

This chain reaction is initiated by the formation of peroxy radicals (RO₂). The propensity of organic compounds to undergo such multistep autoxidation determines the ignition timing of fuels in engines and, on the other hand, the potential for the formation of low-volatility condensable vapors and consequently organic aerosol in the atmosphere. The extent to which multistep autoxidation takes place depends on the molecular structure of the organic compounds and the reaction conditions. Determining the different reaction pathways of peroxy radicals, which are important intermediates

in all oxidation reactions, is crucial for the formation of the different reaction products and their key properties, which can ultimately affect both human health and the climate.

Since peroxy radicals are very reactive, their chemical reactions take place very quickly and individual reaction steps were thus overlooked for a long time. The discovery of highly oxygenated organic molecules (HOMs) seven years ago was only possible due to advances in measurement techniques. A special mass spectrometer (Chemical Ionisation - Atmospheric Pressure Interface - Time of Flight (CI-API-TOF) mass spectrometer), that can monitor the very short-lived compounds, was used now to measure the radicals and oxidation products of alkanes. "Until now, there have been no studies on HOM formation from alkanes because it was assumed that their structure would be unfavorable for autoxidation," reports Dr. Torsten Berndt from TROPOS. Methane, an important greenhouse gas, belongs to the group of alkanes. But the most important fossil fuels of the world economy from crude oil and natural gas also consist of alkanes: propane, butane, pentane, hexane, heptane, and octane. New findings about the oxidation behavior of this group of substances, therefore, have great relevance in many areas.

To gain a deeper insight into alkane autoxidation, experiments were carried out in the free-jet flow reactor at TROPOS in Leipzig in addition to experiments in Helsinki. The experimental set-up is optimized so that the gases do not come into contact with the walls during the reaction to exclude interferences of the results by wall processes. During the experiments, almost all reactive intermediates, RO₂ radicals, and their reaction products could be directly monitored. The interdisciplinary cooperation of researchers from combustion chemistry and atmospheric chemistry proved to be very useful, because in the combustion processes analogous processes take place as in the atmosphere, only at a higher temperature. "As a result, it became visible that not only isomerization reactions of RO₂ radicals but also of RO radicals are responsible for the build-up of higher oxidized products. The study made it possible to identify with the alkanes the last and perhaps most surprising group of organic compounds for which autoxidation is important," Torsten Berndt concludes.

Even at high concentrations of nitrogen oxides, which otherwise quickly terminate autoxidation reactions, the alkanes produce considerable amounts of highly oxidized compounds in the air. The new findings allow for a deeper understanding of autoxidation processes and give rise to further investigations on isomerization reactions of RO radicals.

b) Determine which of the following statements match the content of the text (True), which do not match (False), and what the text does not say (Not Stated).

- 1) Researchers have been able to prove that hydrocarbons contribute to air pollution.

- 2) The propensity of organic compounds to multistep autoxidation determines the ignition timing of fuels in engines.
- 3) Since peroxy radicals are not very reactive, their chemical reactions take place very slowly.
- 4) Determining the different reaction pathways of peroxy radicals is crucial for the formation of the different reaction products and their key properties, which can ultimately affect the climate.
- 5) The most important fossil fuels of the world economy from crude oil and natural gas consist of alkanes, alkenes, alkadienes, and arenes.

c) Match the terms and their definitions.

Term	Definition
1) combustion	a) The property of a substance to convert into vapor or gas without chemical change.
2) autoxidation	b) Hydrocarbons containing oxygen molecules that are formed in the atmosphere via autoxidation involving peroxy radicals arising from volatile organic compounds (VOC).
3) volatility	c) A sequence of reactions where a reactive product or by-product causes additional reactions to take place.
4) natural gas	d) The sequence of exothermic chemical reactions between a fuel and an oxidant accompanied by the production of heat and conversion of chemical species.
5) chain reaction	e) A soft ionization technique used in mass spectrometry.
6) isomerization	f) Any oxidation that occurs in open air or in presence of oxygen and/or UV radiation and forms peroxides and hydroperoxides.
7) highly oxygenated organic molecules (HOMs)	g) A mixture of gaseous hydrocarbons associated with petroleum deposits; mostly methane with smaller amounts of ethane, propane, and butane; principally used as a fuel.
8) chemical ionization	h) The conversion of a compound into a different isomeric form.

d) Visit a website publishing research articles in Chemistry, choose an article, read and summarize its content using the plan and useful phrases in the Appendix. The length of the summary should be about 10 % of the original text.

Unit 4. Analytical Chemistry

1. Read the text and think why this branch of chemistry is important. Which of the methods described in the article do you use in your research work?

Analytical chemistry is the analysis of material samples to gain an understanding of their chemical composition and structure. It has a wide range of applications from routine quality control in industrial settings to cutting-edge chemical research in developing new compounds. Monitoring pollution in the environment, development of new materials, drug manufacture, and even forensic science all make use of techniques and methods developed in analytical chemistry. While the focus of this article is the functions in a laboratory setting, analytical chemistry is involved in many synthetic or man-made creations. As such, analytical chemistry is a foundational arena for the infinite unfolding of human creativity.

Analytical chemistry can be split into two main types, qualitative and quantitative. The qualitative inorganic analysis seeks to establish the presence of a given element or inorganic compound in a sample. The quantitative analysis seeks to establish the amount of a given element or compound in a sample.

Most modern analytical chemistry is quantitative. Quantitative analysis can be further split into different areas of study. The material can be analyzed for the amount of an element or the amount of an element in a specific chemical species. The latter is of particular interest in biological systems; the molecules of life contain carbon, hydrogen, oxygen, nitrogen, and other elements.

There is a bewildering array of techniques available to separate, detect and measure chemical compounds.

- Separation of chemicals to measure the weight or volume of a final product. This process can be quite painstaking, but is an essential first step when dealing with certain mixtures of substances, like extracts from organisms. Modern separation techniques such as high-performance liquid chromatography (HPLC) often seek to separate and determine the amount or identity in a single automated analysis by integrating a detector.
- Titration is a technique used to determine amounts of a substance present in a solution or physical characteristics of a molecule such as an equilibrium constant.
- Analysis of substances with devices using spectroscopy. By measuring the absorption or emission of light by a substance we can calculate the amounts of species or characterize the chemical species, often without separation. Newer methods include

infra-red spectroscopy (IR), atomic absorption spectroscopy (AAS), nuclear magnetic resonance (NMR), and neutron activation analysis (NAA).

- Mass spectrometry is used to determine the molecular mass, the elemental composition, structure, and amount of chemical species in a sample by ionizing the analyte molecules and observing their behavior in electric and magnetic fields.
- Many techniques combine two or more analytical methods (sometimes called "hyphenated" methods). Examples of this include ICP-MS (Inductively-Coupled Plasma - Mass Spectrometry), where volatilization of a sample occurs in the first step, and measuring of the concentration occurs in the second one. The first step may also involve a separation technique, such as chromatography, and the second step a detection/measuring device.
- Techniques that involve volatilization aim to produce free atoms of the elements making up the sample, which can then be measured in concentration by the degree to which they absorb or emit at a characteristic spectral frequency. These methods have the disadvantage of destroying the sample, and any species contained within it. These techniques include atomic absorption spectroscopy and ICP-MS / ICP-AES. These techniques can still be used to study speciation, however by the incorporation of a separation stage before volatilization.

Source link: https://www.newworldencyclopedia.org/entry/Analytical_chemistry

2. Match the terms (1-13), transcriptions (1-13), and translations (a-m).

1) adsorption	1. [ˌkɛmɪˌluːmɪˈnɛns]	a) хроматограф
2) aliquot	2. [ˌvɒltʰæmɛtrɪ]	b) дилатометр
3) chemiluminescence	3. [ɪksˈtrækʃ(ə)n]	c) экстракция
4) chromatofocusing	4. [ˌdɪləˈtɒmɪtə]	d) индикатор
5) chromatograph	5. [ɪˈlɛktrəfəˈrɪːsɪs]	e) аликвотная проба; аликвота
6) colorimetry	6. [ˌspɛktrəʊfəˈtɒmɛtrɪ]	f) хроматофокусирование
7) dilatometer	7. [ædˈsɔ(:)pʃən]	g) калориметрия
8) electrophoresis	8. [taɪˈtreɪʃ(ə)n]	h) спектрофотометрия
9) extraction	9. [ˌkrəˈmætəˈfʊkəsɪŋ]	i) титрование
10) indicator	10. [ˌklɪərˈɪmɛtrɪ]	j) адсорбция
11) spectrophotometry	11. [ˈæliˌkwɒt]	к) вольтамперометрия
12) titration	12. [ˈɪndɪkeɪtə]	л) хемилюминесценция
13) voltammetry	13. [ˌkrəˈmætəˌɡrɑːf]	м) электрофорез

3. For each definition choose a suitable term from task 2.

- 1) A small amount of an easily detected substance that can be used to follow and quantify the flow of materials not otherwise visible or detectable by ordinary means.
- 2) The process of obtaining one material from another by washing with a solvent to remove adsorbed material from an adsorbent (as in washing of loaded ion-exchange resins to remove captured ions) by chemical or physical or mechanical means; used to obtain uranium ions.
- 3) An instrument that enables a sophisticated separation, e.g. gas chromatographic or liquid chromatographic separation.
- 4) A fractional part of a specimen used for testing that is taken as a sample representing the whole specimen.
- 5) A quantitative chemical analysis by color using a colorimeter used to determine the concentration of a colored solution, to quantify and describe physically the human color perception.
- 6) The determination of the concentration of some substance in a solution by slowly adding measured amounts of some other substance (normally using a burette) until a reaction is shown to be complete, for instance by the color change of an indicator.
- 7) The quantitative analysis of electromagnetic spectra to determine the structure or quantity of a substance.
- 8) The motion of charged particles in a colloid under the influence of an electric field used to separate molecules as an analytical or preparative technique.
- 9) A process in which material (adsorbate) travels from a gas or liquid phase and forms a superficial monomolecular layer on a solid or liquid condensed phase (substrate).
- 10) An instrument used to measure the expansion of solids and liquids when heated, or when subjected to some other physical process.
- 11) A set of electrochemical methods of quantitative and qualitative analysis based on the determination of the relationship between the current strength and the polarization voltage during the electrolysis of a solution or melt of the explored substance.
- 12) The emission of light, as the result of a chemical reaction, where may also be limited emission of heat.
- 13) A protein-separation technique that allows the resolution of single proteins and other ampholytes from a complex mixture according to differences in their isoelectric point.

4. Complete the paragraphs using the terms from task 2. In some sentences, the plural form is required. In each paragraph, the same word is missing.

- 1) _____ (also known as volumetric analysis) is a common laboratory method of quantitative analysis used to determine the concentration of an identified analyte. A reagent, termed the titrant or titrator, is prepared as a standard solution of known concentration and volume. In volumetric _____, a reagent is slowly added to the analyte. The titrant reacts with a solution of the analyte to determine the analyte's concentration. The volume of titrant that reacted with the analyte is termed the titration volume. This overall process is equivalent to a semi-batch reaction because the total analyte volume increases (slightly) over time. Therefore, by extension, the _____ model is also a semi-batch reactor model.
- 2) The potential of a solution during a redox reaction can be followed with electrodes. The potential is usually measured across a platinum electrode and an electrode that supplies a standard potential. Chemical _____ can be used and are compounds that are oxidized or reduced and change colors between the two forms. The endpoint of iodine titrations is conveniently followed with starch _____, as small amounts of iodine form a dark blue complex with it. Titrants or analytes that are highly colored can be used as self _____.
- 3) A _____ is a scientific instrument that measures volume changes caused by a physical or chemical process. A familiar application of a _____ is the mercury-in-glass thermometer, in which the change in volume of the liquid column is read from a graduated scale. Because mercury has a fairly constant rate of expansion over ambient temperature ranges, the volume changes are directly related to temperature. _____ have been used in the fabrication of metallic alloys, a study of martensite transformation, compressed and sintered refractory compounds, glasses, ceramic products, composite materials, and plastics.
- 4) Several separate subsamples, or _____, are used for the measurement of each point on the growth curve so that between 20 and 60 _____ are used for each ED determination. An alternative to such multiple _____ methods is to make all the measurements on a single _____. The methods used are very similar to those for multiple _____, with both additive dose and regenerative measurements possible.
- 5) _____ is the luminescence resulting from the energy release of a chemical reaction usually between hydrogen peroxide (H_2O_2) and a high-energy compound. Because it does not require genetic modification, it is a convenient technique with greater clinical potential than bioluminescence.
- 6) The innovative idea for developing a new gamma-ray dosimetry system is based on optical _____ techniques, making use of color standards. The color standards

are officially recognized instruments, containing standardized colors (pure color and well-determined ratios of mixtures), used for comparison with other unknown tones of a specific color (determined in the same measuring conditions). A color standard is used to describe the _____ characteristics of a sample and also to assure a traceability chain.

- 7) _____ is a surface process that leads to the transfer of a molecule from a fluid bulk to a solid surface. This can occur because of physical forces or by chemical bonds. In most cases, this process is described at the equilibrium employing some equations that quantify the amount of substance attached to the surface given the concentration in the fluid. These equations are called isotherms (the most famous are the Langmuir and the Freundlich equations) because of the dependence of their parameters on the temperature, which is one of the most important environmental factors affecting _____. _____ has a fundamental role in ecology: it regulates the exchanges between geosphere and hydrosphere and atmosphere, accounts for the transport of substances in the ecosystems, and triggers other important processes like ionic exchange and enzymatic processes.
- 8) _____ in chemistry is a separation process consisting in the separation of a substance from a matrix. Common examples include liquid-liquid _____, and solid-phase _____. The distribution of a solute between two phases is an equilibrium condition described by partition theory. This is based on exactly how the analyte moves from the initial solvent into the extracting solvent. The term washing may also be used to refer to an _____ in which impurities are extracted from the solvent containing the desired compound.
- 9) _____ is the quantitative measurement of the interaction of ultraviolet (UV), visible, and infrared (IR) radiation with a material and has an impact on a wide field of science and technology. _____ deals with the measurement of the interaction of light with materials. Light can be reflected, transmitted, scattered, or absorbed, and a material can emit light, either because it has absorbed some light and reemits it because it has gained energy in some other way (e.g., electroluminescence), or because it emits light due to its temperature (incandescence).
- 10) _____ is an electrochemical technique in which a varying potential is applied to a working electrode in an electrochemical system, and the corresponding current is measured. _____ at solid electrodes does not offer significant advantages over amperometry using the same electrode types and requires more sophisticated instrumentation. _____ and coulometry, therefore, remain as the electrochemical methods of choice. _____ (and its related techniques, amperometry, and potentiometry) encompass a family of techniques that measure the potential or current between electrodes, which in turn depends on changes in their electrochemical potentials due to target binding.

- 11) _____ of positively charged particles is called cataphoresis, while _____ of negatively charged particles is called anaphoresis. The electrokinetic phenomenon of _____ was observed for the first time in 1807, the application of a constant electric field caused clay particles dispersed in water to migrate. It is ultimately caused by the presence of a charged interface between the particle surface and the surrounding fluid. It is the basis for analytical techniques used in chemistry for separating molecules by size, charge, or binding affinity.
- 12) Gas _____ have not often been used as detectors. Flame ionization detectors do not respond to small amounts of arsine. With a thermal conductivity detector, the detection limit was 10 µg/l and with a gold gas-porous electrode detector 40 µg/l. Liquid _____, compared to mass spectrometers, have far more user-accessible components. In a standard clinical laboratory, the liquid _____ system also requires the most care.
- 13) _____ utilizes ion exchange resins and is typically performed on fast protein liquid chromatography (FPLC) or similar equipment capable of producing continuous buffer gradients though this is not a requirement. In contrast to typical ion-exchange chromatography, where bound molecules are eluted from the resin by increasing the ionic strength of the buffer environment, _____ elutes bound species by altering the pH of the buffer. This changes the net surface charge of bound molecules, altering their avidity for the resin.

5. Match the terms (1-17), transcriptions (1-17), and translations (a-q).

1) absorption spectroscopy	1.[ˈdɪfəˈrenʃ(ə)lˈskæɪŋ ,kæləˈrɪmətri]	a) флуоресцентная спектроскопия
2) atomic emission spectroscopy (AES)	2.[ˈgæs,kɹəʊməˈtɔgrəfi]	b) гравиметрический анализ
3) Auger-electron spectroscopy	3.[pə,təŋʃiəˈmetɹɪk taɪˈtreɪʃ(ə)n]	c) нейтронно-активационный анализ (НАА)
4) matrix spike	4.[ˈmæsspəkˈtrɒmətri]	d) пробоподготовка
5) fluorescence spectroscopy	5.[ˈnju:trɒnˈæktiˈveɪʃ(ə)n əˈnæɪlɪsɪs]	e) рентгеноструктурный анализ, рентгеновская кристаллография
6) (GC) gas chromatography	6.[əbˈzɔ:pʃ(ə)n spəkˈtrɒskəpi]	f) потенциометрическое титрование

7) gravimetric analysis	7.[ˈsɑ:m(p(ə)l ˈpreɪəˈreɪʃ(ə)n]	g) абсорбционная спектроскопия
8) (MS) mass spectrometry	8.[ˈeksreɪ flʊəˈres(ə)ns əˈnæləsɪs]	h) атомно-эмиссионная спектроскопия (АЭС)
9) differential scanning calorimetry (DSC)	9.[ˈɔ:ʒəɪˈlektən spækˈtrɔ:skəpɪ]	i) дифференциальная сканирующая калориметрия
10) neutron activation analysis (NAA)	10.[rɪˈdju:ʃnˈeɪdʒənt]	j) рентгенофлуоресцентный анализ (РФА)
11) nuclear magnetic resonance (NMR)	11.[ˈeksreɪˈkrɪstəˈlɔ:græfɪ]	k) термогравиметрический анализ
12) potentiometric titration	12.[θɜ:məʊˌgrævəˈmetrɪk əˈnæləsɪs]	l) масс-спектрометрия
13) reducing agent	13.[əˈtɔ:mɪkɪˈmɪʃ(ə)n spækˈtrɔ:skəpɪ]	m) восстановитель
14) sample preparation	14.[grævɪˈmetrɪk əˈnæləsɪs]	n) ядерно-магнитный резонанс (ЯМР)
15) thermogravimetric analysis (TGA)	15.[ˈnju:lɪəmədʒˈnetɪk ˈrezənəns]	o) электронная Оже-спектроскопия
16) X-ray crystallography	16.[flʊəˈresns spækˈtrɔ:skəpɪ]	p) газовая хроматография
17) x-ray fluorescence (XRF) analysis	17.[ˈmeɪtrɪksˌspɑ:k]	q) проба матрицы с известной добавкой

6. For each definition (1-17) choose a suitable term from task 5 (1-17).

- 1) A common analytical technique used specifically in the study of surfaces and in the area of materials science based on the Auger effect based on the analysis of energetic electrons emitted from an excited atom.
- 2) An analytical technique, a type of electromagnetic spectroscopy that analyzes the fluorescence produced by a sample. It involves using a beam of light, usually ultraviolet light, that excites the electrons in molecules of certain compounds and causes them to emit light; typically, but not necessarily, visible light.

- 3) The spectroscopic technique that is employed as an analytical chemistry tool to determine the presence of a particular substance in a sample and, in many cases, to quantify the amount of the substance present, that measure the absorption of radiation, as a function of frequency or wavelength, due to its interaction with a sample.
- 4) A technique similar to direct titration of a redox reaction that uses no indicator, the potential is measured across the analyte (an electrolyte solution).
- 5) A non-destructive physical method based on the emission of characteristic "secondary" X-rays from a material that has been excited by bombarding with high-energy X-rays or gamma rays that is used for chemical elemental analysis of materials in the solid or liquid state.
- 6) A nuclear process used for determining the concentrations of elements in a vast amount of materials that allows discrete sampling of elements as it disregards the chemical form of a sample, and focuses solely on its nucleus.
- 7) A sample prepared by adding a known quantity of analyte to an aliquot of an environmental sample and subjecting the sample to the entire analytical procedure to determine the ability to recover the known analyte or compound.
- 8) Any of several methods and techniques of analytical chemistry, a quantitative analysis, in which the amount of a substance in a sample is determined by weighing a precipitate, filtrate, residue, etc after some physical or chemical process.
- 9) A substance that causes reduction of another substance in a chemical reaction, as by donating electrons or adding hydrogen atoms.
- 10) A scientific method in which the crystalline structure causes a beam of incident X-rays to diffract into many specific directions, that is used in the field of materials characterization to obtain information on the atomic scale structure of various substances in a variety of states.
- 11) A method of processing a sample before its analysis that involves dissolution, extraction, reaction with some chemical species, pulverizing, treatment with a chelating agent (e.g. EDTA), masking, filtering, dilution, sub-sampling, or many other techniques.
- 12) An analytical technique that measures the mass/charge ratio of the ions formed when a molecule or atom is ionized, vaporized, and introduced into a vacuum, that may also involve breaking molecules into fragments - thus enabling its structure to be determined.
- 13) A common type of chromatography used in analytical chemistry for separating and analyzing compounds that can be vaporized without decomposition, that includes testing the purity of a particular substance, or separating the different components of a mixture.

- 14) A method of chemical analysis that uses the intensity of light emitted from a flame, plasma, arc, or spark at a particular wavelength to determine the quantity of an element in a sample.
- 15) A thermal analysis technique in which a tiny sample pan is heated together with an empty reference pan and the difference in heat flow between the two measured as a function of temperature.
- 16) A versatile and highly sophisticated spectroscopic technique including the absorption of electromagnetic radiation (radio waves), at a specific frequency, by an atomic nucleus placed in a strong magnetic field used to precisely identify the molecular structure of the compound.
- 17) A method of thermal analysis in which the mass of a sample is measured over time as the temperature changes that provides information about physical phenomena, such as phase transitions, absorption, adsorption, and desorption; as well as chemical phenomena including chemisorptions, thermal decomposition, and solid-gas reactions (e.g., oxidation or reduction).

7. Complete the paragraphs using the terms studied in this unit (task 5). In some sentences the plural form is required. In each paragraph, the same word is missing.

- 1) _____ can be used to measure many characteristic properties of a sample. Using this technique, it is possible to observe fusion and crystallization events as well as glass transition temperatures. _____ can also be used to study oxidation, as well as other chemical reactions. _____ has been widely used by flow assurance researchers to assess wax crystallization in crude oils. The event of interest that can be detected through _____ is accordingly an exothermic crystallization peak whose onset corresponds to a measurement of the Wax Precipitation Temperature (WPT).
- 2) _____ is a sensitive multi-element analytical technique used for both qualitative and quantitative analysis of major, minor, trace, and rare elements. _____ is a highly sensitive method for the accurate determination of elemental concentrations in a material. _____ method is based on the detection and measurement of characteristic gamma rays emitted from radioactive isotopes produced in the sample upon irradiation with neutrons of a nuclear reactor. In the process of _____, the sample is irradiated in a reactor core with thermal neutrons flux for an irradiation time.
- 3) _____ is an element or compound that loses (or "donates") an electron to an electron recipient (oxidizing agent) in a redox chemical reaction. A _____ is thus oxidized when it loses electrons in the redox reaction.

- 4) _____ is an elemental analysis technique that provides quantitative chemical information. The detection limit of _____ is better than that of EDS and the concentration of trace elements can be detected using _____. An analytical crystal of known composition provides fixed interplanar spacing between planes of atoms within the crystal that facilitates differentiation of X-rays emitted from a sample under investigation.
- 5) _____ are instrumental for obtaining the reduction potentials of redox-active centers in proteins. They provide essential information for understanding the roles of these centers in electron and energy transfer processes. _____ in aqueous solutions is a simple and effective method and considered to be the most precise method for the determination of equilibrium constants, once a right model has been chosen.
- 6) _____ is an analytical technique that measures charged, gas-phase molecules based on mass-to-charge (m/z) ratio. The ionization techniques caused fragmentation of the compound during ionization and required the sample to be in the gas phase, limiting the analysis to volatile and thermally stable compounds. Following the perfection of soft ionization techniques in the 1980s, allowing molecules to remain intact during ionization, _____ was utilized for analyzing biological compounds, many of which are thermally labile and non-volatile. The results of _____ are typically presented as a mass spectrum, a plot of intensity as a function of the mass-to-charge ratio.
- 7) The _____ is inherent to the analysis that will be performed. Most of the sample characterization techniques require a small sample cut from the ingot. To perform this cut, a precision disc cutter can be used to minimize heating and material loss. The main objectives of _____ are to purify and enrich analytes before separation and detection. Commonly used _____ techniques are protein precipitation and partitioning-based techniques, e.g., solid-phase extraction (SPE) and liquid-liquid extraction.
- 8) _____ enables the identification of the atomic and molecular structure of a crystal. The determination of the absolute configuration of chiral compounds is one of the most difficult analyses of molecular structures. NMR and spectrometric methods can determine, in principle, only relative stereochemistry. _____ is the only method that can determine the absolute configuration of chiral molecules, based on the anomalous scattering effects of heavy atoms. _____ provides direct structural information on molecules at the atomic level and is recognized as a reliable structure determination method.
- 9) _____ is a simple analytical technique that measures the weight loss (or weight gain) of a material as a function of temperature and used for the determination of kinetic parameters of carbonaceous materials. _____ is one of the most frequently used techniques to study the thermal behavior of solids. The decomposition

of solid fuel is studied by continuously weighing a small sample of fuel while subjecting it to a constant rise in temperature.

- 10) _____ means an additional aliquot of an environmental sample to which a known concentration of the analytes of interest is added before sample preparation, cleanup, and determinative procedures have been implemented. It is used to assess the performance of the method by measuring the effects of interferences caused by the sample matrix and reflects the bias of the method for the particular matrix in question.
- 11) _____ is a type of electromagnetic spectroscopy that analyzes fluorescence from a sample. It involves using a beam of light, usually ultraviolet light, that excites the electrons in molecules of certain compounds and causes them to emit light; typically, but not necessarily, visible light. A complementary technique is absorption spectroscopy. In the special case of single-molecule _____, intensity fluctuations from the emitted light are measured from either single fluorophores, or pairs of fluorophores.
- 12) _____ is a surface-specific analytical technique that utilizes a high-energy, finely focused electron beam as an excitation source. Auger electrons are produced when the excited atoms release the extra energy to an electron that is then emitted as an Auger electron. _____ collects and measures the kinetic energies of the emitted Auger electrons, which are characteristic of elements present at the surface and “near-surface” of a sample. This makes elemental composition analysis possible. The typical sampling depth of _____ is 2 to 5 nm, making it a surface-sensitive analytical technique.
- 13) _____ is a process for separating and analyzing the compounds that can be vaporized without decomposition. _____ has high selectivity and separation efficiency. Thus it is suitable for the chromatographic separation and detection of complex sample matrixes. Moreover, the _____-mass spectrometry method is simple in operation with a cost lower than liquid chromatography.
- 14) _____ is a reliable and well-established technique to identify and quantify gaseous species. The technique relies on the very specific spectroscopic feature of each atom or molecule: electronic transitions in the UV–Visible range, vibrational and rotational transitions in the infrared. _____ identifies and quantifies a species by measuring the intensity decrease of light after propagating through the sample (Beer-Lambert law).
- 15) _____ is a type of lab technique used to determine the mass or concentration of a substance by measuring a change in mass. _____ is a technique through which the amount of an analyte (the ion being analyzed) can be determined through the measurement of mass. _____ depend on comparing the masses of two compounds containing the analyte. The principle behind _____ is that the mass of an

ion in a pure compound can be determined and then used to find the mass percent of the same ion in a known quantity of an impure compound.

- 16) _____ is a method of physical observation in which nuclei in a strong constant magnetic field are perturbed by a weak oscillating magnetic field (in the near field and therefore not involving electromagnetic waves) and respond by producing an electromagnetic signal with a frequency characteristic of the magnetic field at the nucleus. This process occurs near resonance when the oscillation frequency matches the intrinsic frequency of the nuclei, which depends on the strength of the static magnetic field, the chemical environment, and the magnetic properties of the isotope involved; in practical applications with static magnetic fields up to ca. 20 teslas, the frequency is similar to VHF and UHF television broadcasts (60–1000 MHz). _____ results from specific magnetic properties of certain atomic nuclei. _____ spectroscopy is widely used to determine the structure of organic molecules in solution and study molecular physics, crystals as well as non-crystalline materials. _____ is also routinely used in advanced medical imaging techniques, such as in magnetic resonance imaging (MRI).
- 17) _____ is a procedure of analyzing chemicals that employs the intensity of light from a plasma, flame, arc, or spark at a definite wavelength to calculate the quantitative presence of an element in a particular sample. The atomic spectral line wavelength identifies the element and the intensity of light is proportional to the atom count of the element. Spark or arc _____ is used for the analysis of metallic elements in solid samples.

8. Translate the sentences into English. The words in bold should be taken from the unit's list of terms.

- 1) **Гравиметрический анализ** — это набор лабораторных методов количественного анализа, основанных на измерении массы аналита.
- 2) **Спектрофотометрия** — это количественное измерение оптической плотности или пропускания материала в зависимости от длины волны.
- 3) **Абсорбционная спектроскопия** основывается на поглощении света биомолекулами определенной длины волны.
- 4) **Вольтамперометрия** основана на измерении отклика по току как функции потенциала, приложенного к вольтамперометрической ячейке.
- 5) **Нейтронно-активационный анализ** — это ядерный процесс, используемый для определения концентраций элементов в огромном количестве материалов.
- 6) **Рентгеновская кристаллография** — один из наиболее полезных методов выяснения кристаллических структур органических соединений.

7) В системах **атомно-эмиссионной спектроскопии** элементарные частицы атомизируются и ионизируются в высокотемпературной плазме.

8) **Газовый хроматограф** — это устройство для разделения веществ, достаточно летучих для испарения.

9) **Дилатометры** часто включают механизм контроля температуры.

10) В **электронной оже-спектроскопии** для изображения поверхности используется сфокусированный электронный пучок.

11) **Рентгеновская флуоресценция** — это хорошо зарекомендовавший себя метод анализа материалов, который был адаптирован для использования в поточной полупроводниковой промышленности.

12) **Хемилюминесценция** отличается от флуоресценции или фосфоресценции тем, что электронное возбужденное состояние является продуктом химической реакции, а не поглощения фотона.

9. Make words or word combinations by putting the entangled letters in the correct order.

1) eschclnceiueinemm

2) sictonhroufamgoc

3) cgtahrormhopa

4) yoitrmeolrc

5) dmelateitro

6) rrsetoiechplsoe

7) encaoittrx

8) rtdiicano

9) sasm emetsycrpotr

10) ixtram ikesp

11) ecdnirgu aetgn

12) msplea earoaptrnip

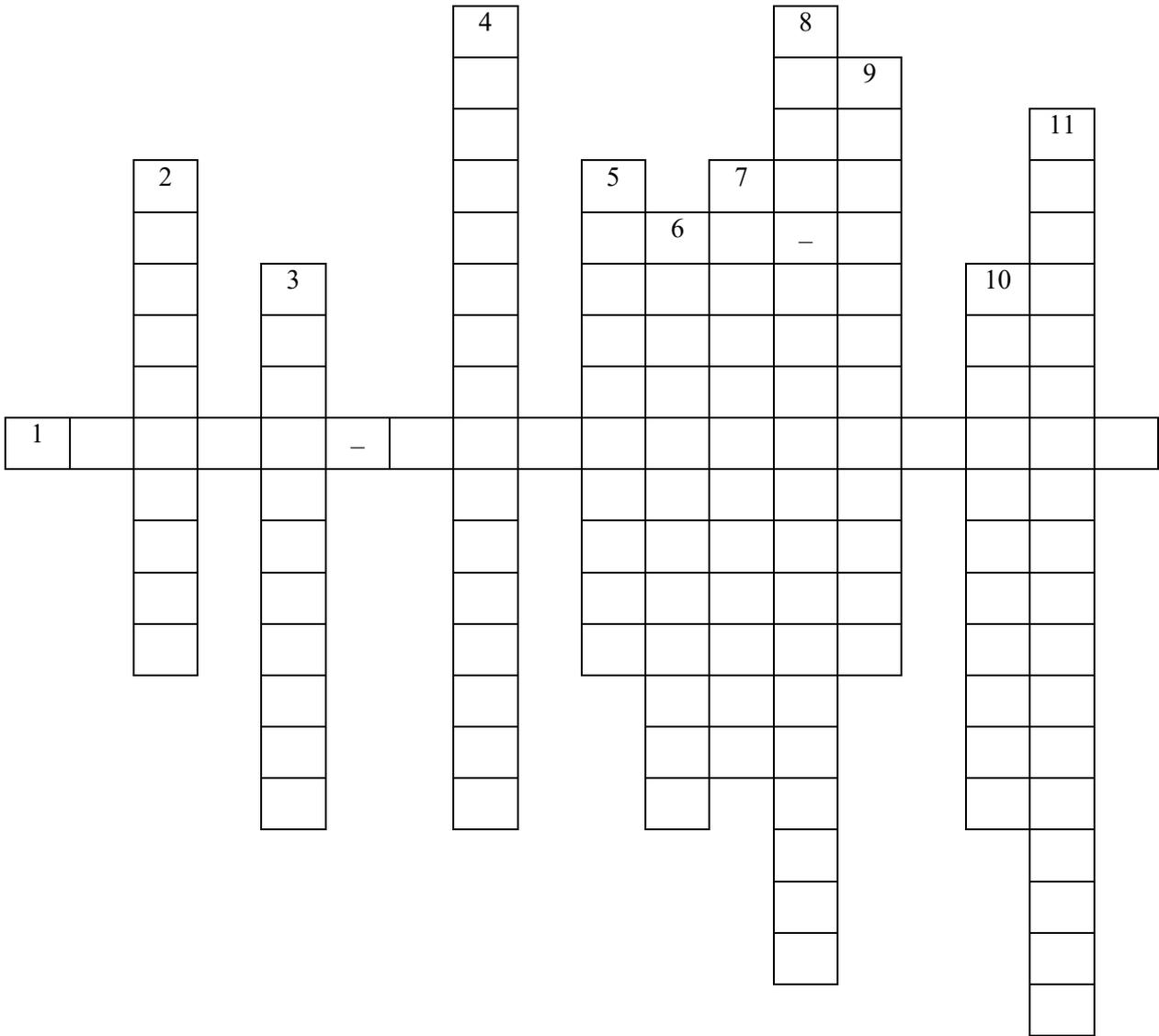
13) hmtocteyerosptopr

14) totatirni

15) vrtolayemmt

10. Solve a crossword puzzle using the terms of this unit.

- 1) An analytical technique that measures charged, gas-phase molecules based on mass-to-charge (m/z) ratio.
- 2) A common laboratory method of quantitative chemical analysis to determine the concentration of an identified analyte (a substance to be analyzed).
- 3) The physical or chemical bonding of molecules of gas, liquid or a dissolved substance to the external surface of a solid or the internal surface, if the material is porous, in a very thin layer.
- 4) The movement of electrically charged particles in a fluid under the influence of an electric field.
- 5) A substance that changes color to indicate the presence of some ion or substance.
- 6) An electrochemical technique in which a varying potential is applied to a working electrode in an electrochemical system, and the corresponding current is measured.
- 7) A scientific technique that is used to determine the concentration of colored compounds in solutions by the application of the Beer–Lambert law, which states that the concentration of a solute is proportional to the absorbance.
- 8) A process for separating and analyzing the compounds that can be vaporized without decomposition.
- 9) A scientific instrument that measures volume changes caused by a physical or chemical process.
- 10) A useful technique of a sample preparation of the separation of a substance from a matrix.
- 11) The quantitative measurement of the absorbance or transmission properties of a material as a function of wavelength.



11. Reading and discussion.

a) Read the text and answer the questions:

1. How many compounds are regulated in drinking water after disinfection?
2. Who proposed a new approach to assessing the quality of drinking water?
3. What is the essence of the new method proposed to the Prasse?
4. What can be determined by the Prasse method?
5. What can the use of chemicals in water treatment lead to?

Method to find toxic in drinking water. Chlorination generates hundreds of unregulated byproducts in water

Source link: <https://www.sciencedaily.com/releases/2021/01/210112125157.htm>

Date: January 12, 2021

Source: Johns Hopkins University

Summary: Most consumers of drinking water in the United States know that chemicals are used in the treatment processes to ensure the water is safe to drink. But they might not know that the use of some of these chemicals, such as chlorine, can also lead to the formation of unregulated toxic byproducts.

Johns Hopkins Environmental Health and Engineering Prof. Carsten Prasse proposes a new approach to assessing drinking water quality that could result in cleaner, safer taps.

"We are exposing people in the United States to these chemical compounds without knowing what they even do," Prasse said. "I'm not saying that chlorination is not important in keeping our drinking water safe. But there are unintended consequences that we have to address and that the public needs to know about. We could do more than what we're doing."

Among disinfection byproducts, only 11 compounds are currently regulated in drinking water, according to his paper published in the Royal Society of Chemistry journal *Environmental Science: Processes & Impacts*. This is in stark contrast to the more than 700 disinfection byproducts that have so far been identified in chlorinated drinking water, he said.

Prasse said the number of disinfection byproducts that are regulated in drinking water has not changed since the 1990s, despite clear scientific evidence for the presence of other toxic compounds.

The existing approach to evaluate chemicals in drinking water is extremely tedious and based on methods that are often outdated, he said. For instance, chemicals are currently evaluated for toxicity by expensive, time-consuming animal studies.

Applying those same methods to the growing number of chemicals in drinking water would not be economically feasible, Prasse said. At a minimum, he added, new methods are needed to identify chemicals that are of the highest concern.

Prasse proposes casting a bigger net to capture a more diverse mix of chemicals in water samples. The "reactivity-directed analysis" can provide a broader readout of what's present in drinking water by targeting the largest class of toxic chemicals known as "organic electrophiles." "This method can help us prioritize which chemicals we need to be paying closer attention to with possible new regulations and new limits while saving time and resources," Prasse said.

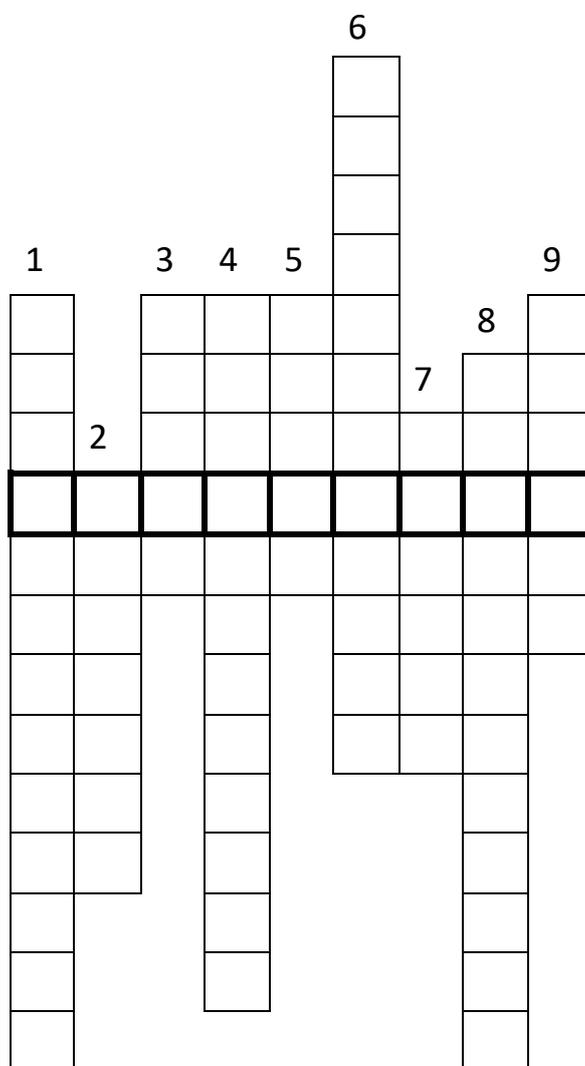
This new approach, which takes advantage of recent advances in the fields of analytical chemistry and molecular toxicology, identifies toxicants based on their reactivity with biomolecules such as amino acids, the building blocks of proteins. The new approach simulates this process to identify toxic chemicals in drinking water.

"We know that the toxicity of many chemicals is caused by their reaction with proteins or DNA which alter their function and can result, for example, in cancer," Prasse said.

b) Complete the sentences from the text and you can see the word that is missing in the title of the article.

1. The "reactivity-directed analysis" can provide a broader readout of what's present in drinking water by targeting the largest class of toxic chemicals known as "organic"
2. Johns Environmental Health and Engineering Prof. Carsten Prasse proposes a new approach to assessing drinking water quality that could result in cleaner, safer taps.
3. Applying those same methods to the growing number of chemicals in drinking would not be economically feasible, Prasse said.
4. This new approach, which takes advantage of recent advances in the fields of analytical chemistry and molecular toxicology, identifies toxicants based on their reactivity with such as amino acids, the building blocks of proteins
5. But they might not know that the use of some of these chemicals, such as chlorine, can also lead to the formation of unregulated byproducts.
6. Prasse said the number of byproducts that are regulated in drinking water have not changed since the 1990s, despite clear scientific evidence for the presence of other toxic compounds.

7. We know that the toxicity of many chemicals is caused by their reaction with proteins or DNA which alter their function and can result, for example, in
8. I'm not saying that is not important in keeping our drinking water safe
9. proposes casting a bigger net to capture a more diverse mix of chemicals in water samples.



c) Visit one of the websites <https://academic.oup.com/>, <http://abc-chemistry.org/>, <http://www-jmg.ch.cam.ac.uk/data/c2k/cj/> or any other website publishing research articles in Chemistry, choose an article, read and summarize its content using the plan and useful phrases in the Appendix. The length of the summary should be about 10 % of the original text.

Unit 5. Physical Chemistry

1. Read the text and say what physical chemists build their theories. Which aspect of physical chemistry are you occupied with?

Physical chemistry is the study of how matter behaves on a molecular and atomic level and how chemical reactions occur. Based on their analyses, physical chemists may develop new theories, such as how complex structures are formed. Physical chemists often work closely with materials scientists to research and develop potential uses for new materials.

Physical chemistry gives students broad training and positions them to work in a variety of scientific careers. Many people trained as physical chemists are employed as analytical chemists working to understand the fundamental processes involved in analytical techniques and expanding those techniques.

Physical chemists are focused on understanding the physical properties of atoms and molecules, the way chemical reactions work, and what these properties reveal. Their work involves analyzing materials, developing methods to test and characterize the properties of materials, developing theories about these properties, and discovering the potential use of the materials. Using sophisticated instrumentation and equipment has always been an important aspect of physical chemistry. Physical chemistry labs are full of analytical instruments, such as lasers, mass spectrometers, nuclear magnetic resonance, and electron microscopes.

Physical chemists' discoveries are based on understanding chemical properties and describing their behavior using theories of physics and mathematical computations. Physical chemists predict properties and reactions of chemicals, then test and refine those predictions. They use mathematical analysis and statistics on huge datasets, sometimes with millions of data points, to reveal hidden information about compounds, materials, and processes. They may also conduct simulations, developing mathematical equations that predict how compounds will react over time.

Recently, more and more physical chemists have found homes in the emerging fields of materials science and molecular modeling where their skills in analyzing and predicting the behavior of physical properties have exciting new applications. By combining the mathematical rigidity of physical chemistry with the practicality of new materials and new applications, the field of physical chemistry is expanding in new and exciting ways.

Physical chemists work in a variety of different areas, but their common goal is to discover, test, and understand the fundamental physical characteristics of a material—be it solid, liquid, or gas. Precision and attention to detail make their work somewhat similar to analytical chemistry, though physical chemists also stress the importance of applying knowledge of math and physics to develop a thorough understanding of the material. A physical chemistry lab is characterized by the large machines and sophisticated instrumentation these scientists use to test and analyze materials.

Physical chemists generally have a strong curiosity about how things work at the atomic level and enjoy working with lab instrumentation and machines. Many are drawn to the fact that physical chemistry processes are similar to those of engineering, and many chemists enjoy using their knowledge and love of chemistry to make discoveries.

<https://www.acs.org/content/acs/en/careers/college-to-career/areas-of-chemistry/physical-chemistry.html>

2. Match the terms (1-11), transcriptions (1-11), and translations (a-k).

1) adiabatic	1. [ˈentrəpi]	a) солидус
2) enthalpy	2. [ˌhɒməˈdʒiːniəs]	b) эвтектика
3) entropy	3. [ˈenθəlpi]	c) гетерогенный
4) eutectic	4. [ˈlikwɪdəs]	d) энтропия
5) heterogeneous	5. [ˈsɒldəs]	e) диффузия
6) homogeneous	6. [dɪˈfjuːz(ə)n]	f) осмос
7) liquidus	7. [ˌædɪəˈbætiːk]	g) фаза
8) solidus	8. [juːˈtektiːk]	h) энтальпия
9) diffusion	9. [feɪz]	i) гомогенный
10) osmosis	10. [ˈhetərəˈdʒiːniəs]	j) адиабатический, адиабатный
11) phase	11. [ɔzˈmæʊsɪs]	k) ликвидус

3. For each definition (1-11) choose a suitable term from task 2 (1-11).

- The curve (on a graph of temperature versus composition) connecting the temperatures at which a liquid solution is in equilibrium with its vapor and with the solid solution.

- 2) The movement of individual molecules of a substance through a semipermeable barrier from an area of higher concentration to an area of lower concentration.
- 3) A distinct state of matter in a system; matter that is identical in chemical composition and physical state characterized by having relatively uniform chemical and physical properties and separated from other material by the boundary.
- 4) Having one phase in a system or process.
- 5) A homogeneous mixture of substances that melts or solidifies at a single temperature that is lower than the melting point of any of the constituents.
- 6) Occurring without loss or gain of heat, change occurring within a system as a result of a transfer of energy to or from the system in the form of work only; i.e., no heat is transferred.
- 7) A thermodynamic quantity that helps to account for the flow of energy through a thermodynamic process, a measure of the number of specific ways in which a system may be arranged, often taken to be a measure of disorder.
- 8) Having more than one phase (solid, liquid, gas) present in a system or process.
- 9) A line, in a phase diagram, below which a given substance is a stable solid and above which solid and liquid are in equilibrium.
- 10) A type of passive diffusion in which a solvent diffuses across a semi-permeable membrane from an area of low solute concentration to an area of high solute concentration.
- 11) A thermodynamic potential, a measure of the total energy of a thermodynamic system including the internal energy, which is the energy required to create a system, and the amount of energy required to make room for it by displacing its environment and establishing its volume and pressure.

4. Complete the paragraphs using the terms from task 2. In some sentences, the plural form is required. In each paragraph, the same word is missing.

- 1) _____ structure can be identified both by microscopy and by X-ray diffraction and the temperature-dependent _____ response can be achieved by doing in situ measurements varying temperature. The microstructure is used to describe the _____ structure and organization within a specimen and is often quite complicated.
- 2) _____ is the tendency of molecules to spread out to occupy available space. Gases and molecules in a liquid tend to diffuse from a more concentrated environment to a less concentrated environment. Passive transport is the _____ of substances across a membrane. This is a spontaneous process and cellular energy is not expended. Molecules will move from where a substance is more concentrated to where it is less concentrated. The rate of _____ for different substances is affected

by membrane permeability. For instance, water diffuses freely across cell membranes but other molecules can not. They must be helped across the cell membrane through a process called facilitated _____.

- 3) An _____ is a melting composition of two or more components, each of which melts and freezes congruently. During the crystallization phase, a mixture of the components is formed, hence acting as a single component. The components freeze to an intimate mixture of crystals and melt simultaneously without separation. _____ can be mixtures of organic and/or inorganic compounds. Hence, _____ can be made as either organic–organic, inorganic–inorganic, or organic-inorganic mixtures. This gives room for a wide variety of combinations that can be tailored for specific applications.
- 4) Measuring the _____ temperature during cooling is difficult due to undercooling, which is exhibited by many metals and alloys. The nucleation usually occurs on foreign crystals; such as ceramic grains in the crucible, oxide on the melt surface, or fine particles dispersed throughout the melt. Nucleation temperatures can vary from only a fraction of a degree below the _____ to 100 or more degrees below the _____ depending on the alloy system and other factors. The _____ temperature is a thermodynamic quantity. The importance of the _____ temperature for glass melts arises from the fact that all melt-forming should be performed at temperatures higher than the _____.
- 5) _____ is a special case of passive transport. Water diffuses across a semi-permeable membrane which allows some molecules to pass but not others. In _____, the direction of water flow is determined by solute concentration. There is a thermodynamic tendency for solutions separated by such a membrane to become equal in concentration, the water (or another solvent) flowing from the weaker to the stronger solution. _____ will stop when the two solutions reach equal concentration, and can also be stopped by applying pressure to the liquid on the stronger-solution side of the membrane.
- 6) _____ is most conveniently thought of as the heat content of a substance—the amount of energy within a substance that is available for conversion to heat. In chemistry and physics, activation _____ is the energy that must be available to a chemical system with potential reactants to result in a chemical reaction. Svante Arrhenius proposed the Arrhenius equation to give the dependence of the rate of a chemical reaction on the activation _____. _____ is the function of state and its value depends only on the starting and final state of the system.
- 7) In eutectic mixtures, the _____ and liquidus temperatures coincide at a point known as the eutectic point. At the eutectic point, the solid congruently melts (i.e., melts

completely). The _____ quantifies the temperature at which melting of a substance begins, but the substance is not necessarily melted completely, i.e., the _____ is not necessarily a melting point.

- 8) _____ materials are a new class of structural materials with remarkable heterogeneity in strength from one component to another with a variety of shapes, forms, and morphology at different length scales. _____ materials can become dispersive under dynamical conditions in the elastic regime when the incident wavelength and the size of the heterogeneities have the same order of magnitude. The materials most intensively investigated, in the field of nanoscience, represent a subclass of _____ materials.
- 9) An _____ process is a thermodynamic change whereby no heat is exchanged between a system and its surroundings. Evaporative cooling is achieved by an _____ process, in which the sensible air temperature is reduced and compensated by latent heat gain. Electronically non-_____ processes are ubiquitous in chemistry and molecular physics and play a primary role in many technological applications.
- 10) _____ is a measure of the degree of disorder of the system. Recently, _____ production in living systems, such as humans and ecosystems, has been calculated to investigate a general hypothesis on _____ production in the process of development, growth, and aging of organisms and ecosystems. _____ and its derived functions are thus being used as a measure of performances and/or state of health of a system. The value of molar volume employed has a significant influence on the resulting _____ of mixing and thus on the resulting enthalpy.
- 11) A _____ system is one whose properties are either the same throughout the system or vary continuously from point to point with no discontinuities. _____ catalysis occurs when the catalyst is uniformly dispersed in the reaction mixture, either a gaseous or liquid solution. _____ catalysis can be classified into single-species and complex catalysis, although the distinction is not always clear-cut.

5. Match the terms (1-19), transcriptions (1-19), and translations (a-s).

1) chemical potential	1. [ˈɡɪbsʰfriːˈenədʒiː]	a) энергия Гиббса, изобарно-изотермический потенциал
2) colloidal solution	2. [ɡælˈvænikˈsel]	b) энергия Гельмгольца, изо-хорно-изотермический потенциал
3) chemical equilibrium	3. [ˈhelmhɔlts ˈfriːˈenədʒiː]	c) фазовый переход
4) Gibbs free energy	4. [ˈɪntəˈfeɪʃ(ə)lˈtenʃ(ə)n]	d) межфазное натяжение
5) heat capacity	5. [aɪˈdiəlˈɡæs]	e) твердый раствор
6) Helmholtz free energy	6. [ˈθɜːm(ə)l ˌkɒndʌkˈtɪvɪtɪ]	f) окислительно-восстановительный потенциал
7) ideal gas	7. [ˈriːdkspəˈtenʃ(ə)l]	g) химический потенциал
8) phase transition	8. [ˈkemɪk(ə)lpəˈtenʃ(ə)l]	h) конгруэнтное плавление
9) galvanic cell	9. [ˈθɜːm(ə)l ɪkˈspænj(ə)n]	i) удельная теплоемкость
10) solid solution	10. [ˈkɒŋgrʊəntˈmeltɪŋ]	j) закон Рауля
11) thermal conductivity	11. [ˈkemɪk(ə)l ˈiːkwɪˈlɪbrɪəm]	k) коллоидный раствор
12) redox potential	12. [rɑːˈuːlzˈləː]	l) межмолекулярное взаимодействие
13) interfacial tension (IFT)	13. [ˈdɔːltənzˈləː]	m) идеальный газ
14) cloud point	14. [ˈsɔːldʌsˈluːʃ(ə)n]	n) химическое равновесие
15) congruent melting	15. [ˌkɒˈlɔɪd(ə)lsəˈluːʃ(ə)n]	o) тепловое расширение
16) Dalton's law	16. [ˌɪntəməˈlekjʊlə ˌɪntəˈrækʃn]	p) гальванический элемент
17) Raoult's law	17. [ˈhiːtkəˈpsɪtɪ]	q) точка помутнения
18) thermal expansion	18. [ˈklaʊdˈpɔɪnt]	r) теплопроводность
19) intermolecular interaction	19. [ˈfeɪztænˈzɪʃ(ə)n]	s) закон Дальтона

6. For each definition (1-19) choose a suitable term from task 5 (1-19).

- 1) A thermodynamic potential that measures the useful work obtainable from a closed thermodynamic system at a constant temperature and volume (isothermal, isochoric).
- 2) A substance in which a microscopically small solid substance that is equally dispersed throughout a continuous liquid phase.
- 3) A thermodynamic potential that can be used to calculate the maximum reversible work that may be performed by a thermodynamic system at a constant temperature and pressure.
- 4) The state in which both reactants and products are present at concentrations that have no further tendency to change with time that results when the forward reaction proceeds at the same rate as the reverse reaction.
- 5) The physical processes of transition between thermodynamic phases of a physical system: solid, liquid, and gaseous phases of a substance.
- 6) The ability of a material to conduct heat, and represents the quantity of thermal energy that flows per unit time through a unit area with a temperature gradient of 1° per unit distance.
- 7) The temperature at which one component of a mixture of liquids begins to solidify (or a mixture of liquids starts to become immiscible) on cooling, resulting in visible cloudiness.
- 8) The tendency of matter to change its shape, area, volume, and density in response to a change in temperature, usually not including phase transitions.
- 9) The forces which mediate an interaction between atoms, including forces of attraction or repulsion which act between atoms and other types of neighboring particles, e.g. atoms or ions.
- 10) A measure of the tendency of a chemical species to acquire electrons from or lose electrons to an electrode and thereby be reduced or oxidized respectively.
- 11) Isothermal or isobaric melting, in which the solid and liquid phases have the same composition from the beginning to the end of the transformation.
- 12) The law states that the partial vapor pressure of each component of an ideal mixture of liquids is equal to the vapor pressure of the pure component multiplied by its mole fraction in the mixture.
- 13) Law stating that the pressure exerted by a mixture of gases equals the sum of the partial pressures of the gases in the mixture.
- 14) A measurement of excess energy present at an interface arising from the imbalance of forces between molecules at an interface.
- 15) A mixture of two crystalline solids that coexist as a new crystalline solid, or crystal lattice, can be accomplished by combining the two solids when they have been

melted into liquids at high temperatures and then cooling the result to form the new solid or by depositing.

- 16) A theoretical gas composed of many randomly moving point particles that are not subject to interparticle interactions.
- 17) A species of energy that can be absorbed or released due to a change of the particle number of the given species, e.g. in a chemical reaction or phase transition.
- 18) The capability of a substance to absorb heat energy; specifically, the amount of heat required to raise the temperature of one mole or gram of a substance by one degree Celsius without any change of phase.
- 19) An electrochemical cell that derives electrical energy from spontaneous redox reactions taking place within the cell, converts chemical energy into electrical energy.

7. Complete the paragraphs using the terms from task 5. In some sentences, the plural form is required. In each paragraph, the same word is missing.

- 1) _____ of a substance is the energy that sets the direction of a process: movement is from high to low _____. It is a general experimental observation that as the concentration of a substance increases, its contribution to a physical process increasingly deviates from the linear scaling that occurs at low, dilute concentrations. At low concentrations, molecular interactions of the substance do not usually depend on concentration, and distinguishing between _____ and concentration has no practical implications. But at high concentrations, interactions significantly vary with concentration, and the energy is strongly dependent on the details of the interactions. The _____ must be determined experimentally.
- 2) _____ are thermodynamic processes associated with the transfer of substances from one thermodynamic phase to another. There are two types of _____ – the first and second-order ones. The first order _____ is characterized by a discontinuous change of the equation of state, whereas in the case of the second-order _____ – a change of the equation of state is continuous.
- 3) _____ occurs during the melting of a compound when the composition of the liquid that forms is the same as the composition of the solid. It can be contrasted with incongruent melting. This generally happens in two-component systems. _____ point represents a definite temperature just like the melting points of pure components.
- 4) _____ is the tendency of matter to change in volume in response to temperature alterations. When a substance is heated, its particles move more and thus maintain a greater average separation. Since thermosets are used in a solid form they undergo linear _____. The degree of expansion divided by the change in temperature

gives the material's linear coefficient of _____. The coefficient of _____ describes how the size of an object changes with a temperature change. Specifically, it measures the fractional change in size per degree change in temperature at constant pressure, such that lower coefficients describe a lower propensity for change in size.

- 5) In aqueous solutions, _____ is a measure of the tendency of the solution to either gain or lose electrons when it is subjected to change by the introduction of a new species. A solution with a higher (more positive) reduction potential than the new species will have a tendency to gain electrons from the new species and a solution with a lower (more negative) reduction potential will tend to lose electrons to the new species. _____ is measured in volts (V), or millivolts (mV).
- 6) A _____, named after Luigi Galvani, is an electrochemical cell that derives electrical energy from spontaneous redox reactions taking place within the cell. It generally consists of two different metals immersed in electrolytes, or of individual half-cells with different metals and their ions in solution connected by a salt bridge or separated by a porous membrane. The electrochemical processes in a _____ occur because reactants of high free energy are converted to lower-energy products. _____ and batteries are typically used as a source of electrical power.
- 7) _____ is the amount of energy needed to change a unit of mass of a material one degree of temperature. The _____ of plastics, which are obtained at constant pressure, are temperature-dependent, especially near the glass-transition temperature. In a semicrystalline polymer, the _____ of the amorphous phase is greater than the _____ of the crystalline phase implying that the α values depend on the percent of polymer's crystallinity.
- 8) _____ may be divided into two groups as regards stability. Some _____ are a stable state of matter and can be precipitated only with difficulty. These are called lyophilic colloids and include hydrosols of proteins, gelatine, silicic acids, and other substances. When a lyophilic _____ is coagulated, it often becomes a jelly-like mass called a gel. This contains not only the substance from the disperse phase but also a considerable quantity of the solvent. _____ of the other group form a metastable state of matter and are very easily precipitated.
- 9) The _____ is an important basic datum involved in dealing with a wide range of fundamental chemical quantities, including the chemical reaction equilibrium constant; vapor-liquid phase equilibrium, and adsorption coefficient. In a spontaneous process the entropy increases, it corresponds to a decrease in the _____. Otherwise, if the _____ increases, the corresponding process will be non-feasible and non-spontaneous.

- 10) _____ is the lowest temperature at which oil becomes cloudy and the first particles of wax crystals are observed as the oil is cooled gradually under standard conditions. The _____ of the hydrogenated oil is about 20°C, slightly worse than FAME. _____ is the temperature at which wax (paraffin) begins to separate when oil is chilled to a low temperature, and it serves as an important indicator of practical performance in automotive applications in low temperatures.
- 11) _____ are the forces of attraction or repulsion between neighboring atoms, molecules, or ions. A crystal is a supramolecule par excellence. It is the self-assembly of millions of molecules held together in a periodic arrangement at an amazing level of precision by _____ and guided by molecular recognition. The ion-ion, ion-dipole, dipole-dipole, hydrogen bonding, London forces interactions, etc. are _____ on a decreasing energy scale.
- 12) When an alkaline solution is mixed with certain crude oils, surfactant molecules are formed. When the formation of surfactant molecules occurs in situ, the _____ between the brine and oil phases could be reduced. The reduction of _____ causes the microscopic displacement efficiency to increase, which thereby increases oil recovery. There are optimum concentrations of alkaline and salt and optimum pH where the _____ values experience a minimum.
- 13) The _____ is a fundamental model in the physical-chemical description of fluids. Being one of the most known equations in science and engineering, the _____ law entails the simplest relation among pressure, p , volume, V , number of particles, N , and absolute temperature, T , for fluids: $pV=NkT$, where k is the Boltzmann constant. As the _____ law is an important limitation that must be obeyed by any equation of state derived for bulk fluids, a generalization to a confined _____ limit is desired to serve as a reference for equations of state that take the fluid-wall interactions into account.
- 14) Heat conduction in alloys is a mixture of molecular vibration and energy transport by free electrons. Thermal properties of materials, generally referring to _____, thermal diffusivity, and special heat capacity, are very crucial for industrial applications. The _____ of material represents its intrinsic characteristic and is the amount of heat flow per unit area over a surface evaluated primarily in terms of Fourier's Law. The _____ of composite is determined by several factors, including filler type, filler dispersion, and _____ path between fillers.
- 15) According to _____ of partial pressures, the total pressure by a mixture of gases is equal to the sum of the partial pressures of each of the constituent gases. The partial pressure is defined as the pressure each gas would exert if it alone occupied the volume of the mixture at the same temperature. The thermodynamic description of a mixture of ideal gases was completed through the work of J. W. Gibbs (1838–1903), who generalized _____ to define all the partial properties (except volume)

of the components in the mixture to be equal to the values that those properties would have if each component gas alone occupied the volume of the mixture at the temperature of the mixture and at the partial pressure of that component.

- 16) A _____ is a solid-state solution of one or more solutes in a solvent. Such a multi-component system is considered a solution rather than a compound when the crystal structure of the solvent remains unchanged by the addition of the solutes, and when the chemical components remain in a single homogeneous phase. The _____ needs to be distinguished from mechanical mixtures of powdered solids like two salts, sugar, and salt, etc. The mechanical mixtures have a total or partial miscibility gap in the solid state. Examples of _____ include crystallized salts from their liquid mixture, metal alloys, and moist solids. In the case of metal alloys, intermetallic compounds occur frequently.
- 17) The _____ is obtained by integrating the chemical potential for the number of molecules, at constant volume and temperature, and the entropy is then determined from the fundamental thermodynamic equation $A = E - TS$. The molar _____ and the molar entropy for the bulk fluids agree well with results from the relevant equations of state.
- 18) Both _____ and Henry's Law have a form of an equilibrium constant in which the particles are going from the ideal liquid phase to the ideal gas phase. According to _____, the partial pressure of a component above a mixture of liquids is proportional to its mole fraction in solution and its saturated vapor pressure. _____ is valid only for ideal solutions.
- 19) _____ is the point in a chemical reaction at which there is no further change in the relevant ionic and molecular species. _____ principles can be applied with reasonable confidence to most reactions occurring exclusively in the solution phase. _____ analysis allows finding the maximum achievable per-pass conversion and the composition of the reaction mixture at equilibrium. It may suggest measures for improving both conversion and selectivity.

8. Put the parts in order to form a sentence and translate it into Russian. The words in bold are taken from the unit's list of terms.

- 12) The **ideal gas**/ cycle/ thermodynamic/ model/ simulations/model/ widely used/ in gas turbine/ with temperature-independent/ **heat capacities**/ is the most/
- 13) **Chemical potential**/ of molecular/ interactions,/ concentration/ (i.e., activity)/ and quantifies/ the effective/ of any substance/ participating/ accounts for/ thermodynamic/ consequences/ in a process/

- 14) **Redox potential**/ the amount/ characterizes/ instead of/ the ability/ to lose or gain/ of electrons/ available for/ oxidation or reduction/ electrons/ under the specific/ condition/ of a chemical/ species/
- 15) The **interfacial tension**/ and surface conditions/ by various/ between/ are measured/ at reservoir/ techniques/ fluid phases/
- 16) Select materials/ performance/ the best/ with appropriate/ **thermal conductivity**/ is very important/ for achieving/ of components/
- 17) The flow/ **heat capacity**/ the isobaric/ and high pressure/ regions/ to measure/ calorimetric method/ is used/ in high temperature/
- 18) Quenching/ a supersaturated/ cooling rate/ at an adequate/ in water/ **solid solution**/ the formation/ to inhibit/ of precipitates,/ is used/ resulting in/
- 19) **Cloud point**/ at which/ can be observed/ refers to/ in biodiesel/ as a cloudy/ the lowest temperature/ suspension/ crystal formation/
- 20) **Gibbs free energy**/ adsorption process/ and temperature/ in initial concentration/ was investigated/ changes of/ changes/ based on/ of solution/
- 21) In an adsorption system,/ and the intrinsic/ of the adsorbed phase/ system,/ both/ of the whole/ the **Helmholtz free energy**/ **Helmholtz free energy**/ we can determine/
- 22) **Osmotic pressure**/ the concentration/ of particles in/ depends only on/ not on/ the solution,/ their nature/

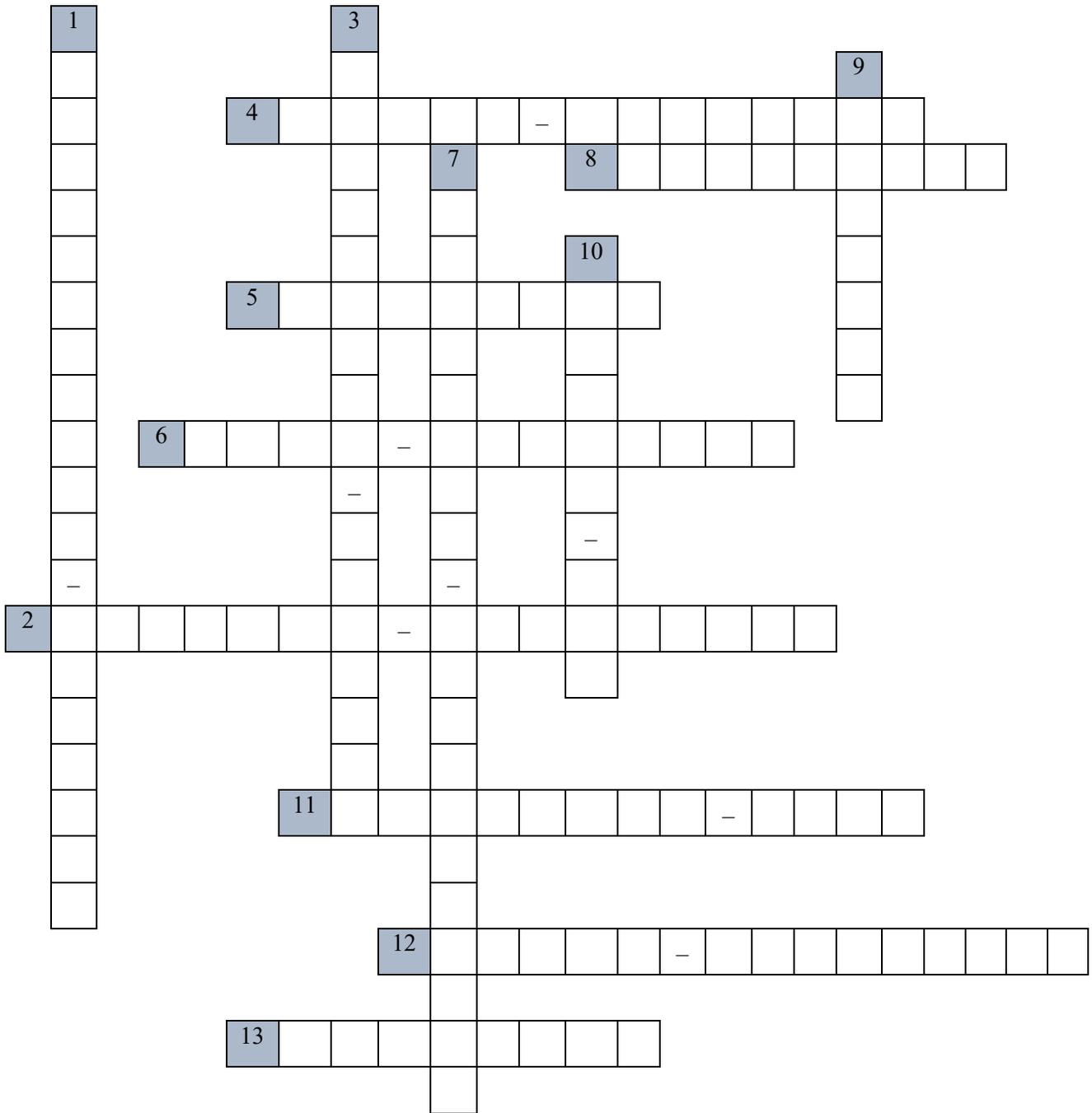
9. Make words or word combinations by putting the entangled letters in the correct order.

- | | | |
|------------------------|-----------------------|--------------------|
| 1) atrelmh | 5) dictbaaia | 10) enlhaytp |
| vtouidtycinc | 6) eugtnonrc ntigml | 11) dslio utsloion |
| 2) aceraitflin ontneis | 7) hlterma anopisnex | 12) rullieonaetrcm |
| 3) uhgeonmsoeo | 8) cteuteic | ticirmoneat |
| 4) paehs nsorntaiit | 9) lidocloal nlusooit | |

10. Solve a crossword puzzle using the terms of this unit.

- 1) The accumulation of energy and the imbalance force at the interface of two different phases such as liquid-solid.
- 2) Increase in linear dimensions of a solid or in a volume of fluid because of temperature rise.
- 3) Melting of a solid substance to a liquid identical in composition.
- 4) A homogeneous solid that can exist over a range of component chemicals; a constituent of alloys formed when atoms of an element are incorporated into the crystals of a metal.
- 5) A minimum-melting composition of two or more components, each of which melts and freeze congruently forming a mixture of the component crystals during crystallization.
- 6) The amount of heat required to raise the temperature of a mass of a substance by 1°C.
- 7) The point in a chemical reaction at which there is no further change in the relevant ionic and molecular species.
- 8) The spontaneous movement and scattering of particles (atoms and molecules), of liquids, gases, and solids.
- 9) The passage of a solvent through a semipermeable membrane separating two solutions of different concentrations.
- 10) A hypothetical gas, whose molecules exhibit no interaction, and undergo elastic collision with each other and with the walls of the container.
- 11) An electrochemical cell that derives electrical energy from spontaneous redox reactions taking place within the cell.
- 12) The difference in voltage between an inert electrode and a system containing oxidation and reduction.

13) A line, in a phase diagram, above which a given substance is a stable liquid and below which solid and liquid are in equilibrium.



11. Reading and summarizing information.

a) Read the text and choose the best title for each paragraph.

- 1) Largely increasing the electrical power
- 2) Maximum electrical power and potential use of waste heat
- 3) Sustainable energy supply
- 4) The new concept of resonant self-actuation
- 5) Low efficiency of thermoelectric generators
- 6) Temperature-dependent magnetic properties

From waste heat to electrical power: A new generation of thermomagnetic generators. Alloy film thickness and footprint influence electrical power

Source link: <https://www.sciencedaily.com/releases/2021/02/210203123402.htm>

(A) Use of waste heat contributes largely to sustainable energy supply. Scientists of Karlsruhe Institute of Technology (KIT) and Tōhoku University in Japan have now come much closer to their goal of converting waste heat into electrical power at small temperature differences. As reported in *Joule*, the electrical power per footprint of thermomagnetic generators based on Heusler alloy films has been increased by a factor of 3.4.

(B) Many technical processes only use part of the energy consumed. The remaining fraction leaves the system in the form of waste heat. Frequently, this heat is released into the environment unused. However, it can also be used for heat supply or power generation. The higher the temperature of the waste heat is, the easier and cheaper is its reuse. Thermoelectric generators can use waste heat of low temperatures for direct conversion into electrical power. Thermoelectric materials used so far, however, have been expensive and sometimes even toxic. Thermoelectric generators require large temperature differences for reaching efficiencies of just a few percent.

(C) Thermomagnetic generators represent a promising alternative. They are based on alloys, whose magnetic properties are highly temperature-dependent. Alternating magnetization induces an electrical voltage in a coil applied. Researchers presented the first concepts of thermomagnetic generators in the 19th century already. Since then, research has covered a variety of materials. Electrical power, however, has left a lot to be desired.

(D) Scientists of KIT's Institute of Microstructure Technology (IMT) and Tōhoku University in Japan have now succeeded in largely increasing the electrical power per footprint of thermomagnetic generators. "Based on the results of our work, thermomagnetic generators are now competitive with established thermoelectric generators for the first

time. With this, we have come closer to the goal of converting waste heat into electrical power at small temperature differences," says Professor Manfred Kohl, Head of the Smart Materials and Devices Group of IMT. The work of the team is reported in the cover story of the latest issue of *Joule*.

Vision: Recovery of Waste Heat Close to Room Temperature

(E) So-called Heusler alloys -- magnetic intermetallic compounds -- are applied in the form of thin films in thermomagnetic generators and provide for a big temperature-dependent change of magnetization and quick heat transfer. This is the basis of the new concept of resonant self-actuation. Even at small temperature differences, resonant vibrations are induced in devices and can be converted efficiently into electrical power. Still, the electrical power of single devices is low, and upscaling will depend on material development and engineering.

(F) The researchers of KIT and Tōhoku University used a nickel-manganese-gallium alloy and found that alloy film thickness and the device footprint influence electrical power in opposite directions. Based on this finding, they succeeded in improving electrical power per footprint by a factor of 3.4 by increasing the thickness of the alloy film from five to 40 micrometers. The thermomagnetic generators reached a maximum electrical power of 50 microwatts per square centimeter at a temperature change of just three degrees Celsius. "These results pave the way to the development of customized thermomagnetic generators connected in parallel for the potential use of waste heat close to room temperature," Kohl explains.

b) Circle the word or phrase to make true statements.

1) Thermoelectric generators require *large/small* temperature differences for reaching efficiencies of a few percent. 2) The *higher/lower* the temperature of the waste heat is, the easier and cheaper is its reuse. 3) *Alternating/permanent* magnetization induces an electrical voltage in a coil applied. 4) Scientists have now succeeded in largely *decreasing/increasing* the electrical power per footprint of thermomagnetic generators. 5) The researchers found that alloy film thickness and the device footprint influence electrical power in *opposite/same* directions.

c) Visit one of the websites publishing research articles in Chemistry, choose an article, read and summarize its content using the plan and useful phrases in the Appendix. The length of the summary should be about 10 % of the original text.

Unit 6. Materials Science

1. Read the text and think about how the development of materials science has influenced society.

Materials science is an interdisciplinary field involving the study of different materials and the applications of knowledge about these materials to various areas of science and engineering. It combines elements of applied physics and chemistry, as well as chemical, mechanical, civil, and electrical engineering. Materials science and materials engineering are often combined into a larger field of study.

Materials used in early human history included metals, glasses, and clay-based ceramics. The past century has witnessed a surge in the development of new materials, including plastics, advanced ceramics, semiconductors, superconductors, liquid crystals, Bose-Einstein condensates, and nanoscale substances, with a wide range of applications. Furthermore, materials science has grown to include testing these more exotic forms of condensed matter and developing new physics theories to explain their behavior. Consequently, materials science has been propelled to the forefront at many academic institutions and research facilities.

Materials research at the basic level can lead to unprecedented influence on society. For example, semiconductor materials, which are ubiquitous in cars, telephones, computers, clocks, kitchen appliances, children's toys, satellites, telescopes, and more, were a product of materials science research—into the electronic properties of the element germanium. Further research led to the replacement of germanium with the less costly silicon and to diverse approaches to modifying silicon's properties by implanting other elements, such as phosphorous or boron, into the silicon matrix. Since their discovery in 1947, semiconductors have been steadily improved through materials science research driven by ever-increasing performance demands from the computer industry.

Materials science is one of the oldest forms of applied science and engineering. In the history of human civilization, different eras have often been retrospectively identified according to an advance in the human ability to work with a new type of material. Examples are the Stone Age, Bronze Age, and Iron Age. A breakthrough in the understanding of materials occurred in the late 19th century when Willard Gibbs demonstrated that thermodynamic properties relating to atomic structure in various phases are related to the physical properties of a material.

Before the 1960s, (and in some cases decades after), many materials science departments at academic and research institutions were named metallurgy departments, because the emphasis was on the study of metals and their uses. The field has since

broadened to include every class of materials, such as ceramics, polymers, semiconductors, superconductors, superfluids, magnetic materials, medical implant materials, and biological materials.

Many important elements of modern materials science have resulted from the space race. In particular, the understanding and engineering of metallic alloys, ceramics, and other materials were useful for the construction of space vehicles, space suits, and so forth, and the new knowledge was found valuable for various consumer and industrial applications as well. Materials science has laid the physical foundations of 21st-century civilization, being integral to everything from fiber optic cables to tennis shoes, and from solar cells to sail boats. Materials science will continue to be centrally important in the quest for finding technological solutions toward sustainable development in the face of environmental degradation and the continued buildup of greenhouse gases due to the burning of carbon-based fuels.

Source link: https://fictionbook.ru/author/lidiya_strautman/introduction_to_the_world_of_physics_met/read_online.html?page=3

2. Match the terms (1-13), transcriptions (a-m), and translations (i-xiii).

1) anisotropy	a) [ˈdi:fəːmeɪf(ə)n]	i.энантиотропия, аллотропия
2) bioplastic	b) [ˌnænəʊməˈtɪəriəl]	ii.пластмасса
3) brazing	c) [riːˈkrɪst(ə)laɪˈzeɪf(ə)n]	iii.тиксотропия
4) composite	d) [ˈbaɪəʊˌplæstɪk]	iv.тягучесть (металла); прочность сопротивления хрупкому излому
5) crystallization	e) [ˈænaɪˈsɒtrəpi]	v.наноматериал
6) deformation	f) [ənˌæntɪˈɒtrəpi]	vi.анизотропия
7) enantiotropy	g) [θɪkˈsɒtrəpi / -ˈsɑ:t-]	vii.перекристаллизация
8) fibreglass	h) [ˈtʌfnɪs]	viii.композиционный материал
9) nanomaterial	i) [ˈfaɪbəglɑ:s]	ix.кристаллизация
10) plastic	j) [ˈbreɪzɪŋ]	x.пайка
11) recrystallization	k) [ˈkɒməzɪt]	xi.биопластик
12) thixotropy	l) [krɪst(ə)laɪˈzeɪf(ə)n]	xii.деформация
13) toughness	m) [ˈplæstɪk]	xiii.стекловолокно

3. For each definition (a-l) choose a suitable term from task 2 (1-13).

- a) Any engineered material composed of two radically different materials in a tightly bonded matrix and having properties significantly different from either constituent.
- b) A bulk material composed of discrete nano-substructures that are engineered, synthesized, and characterized for a myriad of applications.
- c) Any form of synthetic polymer, similar to normal plastic, made from a renewable plant source rather than from petroleum.
- d) A time-dependent phenomenon, best characterized as fluidification of the material under (high) shear and stiffening at rest (or at low shear rates).
- e) A physical property showing different values concerning the direction in or along which the measurement is made.
- f) A metal-joining process in which two or more metal items are joined together by melting and flowing a filler metal into the joint, the filler metal having a lower melting point than the adjoining metal.
- g) A change of the dimensions and in some cases shape of a body due to an applied external force.
- h) A material made from small fibers of glass twisted together, which is used for keeping buildings warm, or a plastic strengthened by these fibers and used for making structures such as the outsides of cars and boats.
- i) Any of a wide range of synthetic or semi-synthetic organic solids that are moldable. They are typically organic polymers of high molecular mass, but they often contain other substances. They are usually synthetic, most commonly derived from petrochemicals, but many are partially natural.
- j) The ability of a material to withstand cracks, i.e. to prevent the transfer or propagation of cracks across its section hence causing failure.
- k) A technique for the purification of chemical compounds in which the compound is dissolved in a solvent and slowly cooled to form crystals.
- l) The possibility for stable polymorphs to exist in different states on either side of a transition-point temperature.
- m) The process of formation of solid crystals precipitating from a solution of a pharmaceutical product produced chemically or through fermentation.

4. Complete the paragraphs using the terms from task 2. In some sentences, the plural form is required. In each paragraph, the same word is missing.

- 1) _____ is an important aspect of process development. Products often drive reactions to completion. Final products are usually crystallized to control and upgrade quality. _____ pressure can be applied by cooling, decreasing the amount of solvent present, adjusting pH, increasing the ionic strength, or adding a component to pro-

mote a reactive _____. Products may oil out if the _____ pressure is too high. Metastable polymorphs may be generated by adding antisolvents and by reactive _____. Reactive _____ can include forming a salt, adjusting the pH to neutralize or ionize a substance, and _____-driven transformations such as _____-induced dynamic resolution and _____-induced asymmetric transformation.

- 2) The use of epoxy and _____ for shell repair has been popular for many years. Epoxy resin with _____ is the preferred method of closure for plastronotomy. However, for traumatic and infected shell injuries, the use of epoxy and _____ is contraindicated, because sealing a contaminated wound will result in infection.
- 3) _____ in the form of nanoparticles, nanofilms, nanoflakes, nanotubes, nanofibers, and nanocomposites have been used in the automotive industry for various purposes, such as improved mechanical, electrical, thermal, corrosion, self-cleaning and anti-wear properties, and sensing abilities. Although these materials have superior properties for various automobile applications, they can be hazardous if they are not properly handled. The toxicity of many _____ has not been completely identified yet, and most studies have focused on lung and liver toxicity of _____.
- 4) The problem of _____ wastes has increased tremendously since the use of _____ increased in most industrial, commercial and residential applications. Households and industries produce a huge amount of _____ waste. _____ waste causes severe environmental problems when incinerated or open burn on roadsides or illegal dumpsites.
- 5) _____ are anisotropic and inhomogeneous materials. _____ is made by combining a minimum of two or more materials, often with different properties. _____ usually present unique properties in which the strength-to-weight ratio is high. Another advantage of _____ is that it provides flexibility in design because the _____ can be molded into complex shapes. There are many types of _____ such as carbon-reinforced fiber plastic, glass fiber-reinforced aluminum, _____ with carbon nanotubes, and many more. Other types of _____ include metal-matrix and ceramic-matrix _____.
- 6) _____ is a basic property of all crystalline materials. Even in nanocrystals and amorphous solids, e.g., metallic glasses, anisotropy is present on an atomic level. Therefore magnetic _____ is an intrinsic property of magnetization in general. _____ measures describe the directional dominance of water diffusion within a region.
- 7) _____ are made wholly or in part from renewable biomass sources such as sugarcane and corn, or microbes such as yeast. _____ are sustainable, largely biodegradable, and biocompatible. Today, _____ have become a necessity in many industrial applications such as food packaging, agriculture and horticulture, composting bags, and hygiene. _____ have also found their use in biomedical, structural, electrical, and other consumer products.

- 8) _____ is a very efficient method to improve the regularity of mesoporous materials. However, only a few research groups realize this method, which is easily confused with the hydrothermal treatment. Both processes are largely different. _____ is a procedure in which as-synthesized powder samples without washing are placed in deionized water at 100–150°C for several days (sometimes even a week).
- 9) _____ is defined as the resistance of a material to crack propagation. If a pipeline were made from low-_____ material, this would be at risk of brittle fracture and would not be able to tolerate cracks. Indeed, the tougher the material, the larger the crack that can be withstood. The main factors that affect _____ level include operational temperature, geometry, and operational stress. Consequently, operating at higher stress levels requires higher _____ material, whereas operating at lower stress levels permits lower _____ levels. _____ is the most remarkable property of hard biological materials.
- 10) In _____, the porosity of the powder metallurgy part can draw away the _____ alloy from the joint region. This can leave insufficient material for bonding. To overcome this problem, techniques have been developed where _____ is integrated into the sintering process. Another potential issue that is encountered commonly in _____ is the presence of secondary products, for example, due to flux reactions which would stop further infiltration by blocking the pores. Factors that can affect the brazed joint in terms of strength are the surface condition of the particles (as is the case for other techniques) and the part's surface roughness; their influence can be significant. There are new _____ techniques, such as laser _____, and new _____ alloys being developed for joining sintered components in large volume.
- 11) _____ is a change of the dimensions and in some cases shape of a body due to an applied external force. The _____ at any point is completely determined by six components of the linear _____, ϵ_x , ϵ_y , ϵ_z , and the angular _____, γ_{xy} , γ_{yz} , γ_{zx} . These components characterize linear and angular changes of the elemental parallelepiped at this point.
- 12) For each solid form, there is a solid-liquid equilibrium curve and a solid–vapor equilibrium curve. In the case of _____, there is an equilibrium curve where both polymorphs are in equilibrium. In cases of ‘monotropy’ there is no thermodynamic transition between two phases since only one solid form is thermodynamically stable.
- 13) _____ is a very important property of adhesives in managing their flow properties during and after dispensing. For rapid dispensing, low viscosity and high flow are required while, immediately after dispensing, reversion to low flow is important so that the adhesive is precisely placed and cured without any lateral or vertical movement. ‘_____’ is shear-thinning property; when an alloy is sheared, it thins, but when it is allowed to stand, it thickens again.

5. Match two parts (1-17 and 1-17) of the terms, which consist of two or more words. Then match the compound terms and their translations (a-q).

1) auxetic	1. coating	a) дефект кристалла
2) carbon fiber	2. casting	b) жесткость скручивания
3) cellulose	3. pressing	с) полутвёрдое формование металла
4) chemical conversion	4. fiber	d) материал матрицы
5) chemical vapor	5. material	e) скрытые трещины, продольный разрыв
6) cold isostatic	6. metal processing	f) непрерывное литьё в кристаллизатор
7) crystal	7. rigidity	g) газофазное химическое осаждение (ГФХО)
8) direct chill	8. nanofiber	h) высокоскоростная механообработка
9) flame	9. material	i) целлюлозное нановолокно
10) functional	10. machining	j) углепластик; пластик, армированный углеродным волокном
11) high-speed	11. material	k) оптоволокно
12) lamellar	12. imperfection	l) химическое преобразующее покрытие, конверсионное покрытие
13) laser	13. reinforced polymer	m) ауксетический материал
14) matrix	14. retardancy	n) огнестойкость
15) optical	15. tearing	o) холодное изостатическое прессование
16) semisolid	16. deposition	p) лазерная обработка материалов
17) torsional (twisting)	17. material processing	q) функциональный материал

6. For each definition (1-17) choose a suitable term from task 5.

- 1) A coating for metals where the part's surface is subjected to a chemical or electrochemical process by the coating material which converts it into a decorative or protective substance.
- 2) A method for the fabrication of cylindrical or rectangular solid ingots from non-ferrous metals, especially Aluminum, Copper, Magnesium, and their alloys.
- 3) A software feature that reduces cycle times, and at the same time, increases the quality of the surface finish.
- 4) A field of materials research, where the power from a laser is used to heat, melt, or ablate materials to change their character or topography, their application to improve the corrosion performance of many types of metallic alloy.
- 5) The minimum force required to deform an object by twisting through a unit dimension (in this case, for twisting the dimension is in the angle of twist).
- 6) A flexible, transparent fiber made of very pure glass (silica) not much bigger than a human hair that acts as a waveguide, or "light pipe," to transmit light between the two ends of the fiber.
- 7) The optically opaque mixture of mineral grains 10nm to 5 μ m in size that rims chondrules, CAIs, and other components and fills in the interstices between them.
- 8) Structures or materials that have a negative Poisson's ratio. When stretched, they become thicker perpendicular to the applied force. This occurs due to their particular internal structure and the way this deforms when the sample is uniaxially loaded.
- 9) A process in which the substrate is exposed to one or more volatile precursors, which react and/or decompose on the substrate surface to produce the desired thin film deposit.
- 10) Any stable violation of the translational symmetry of the crystal — the ideal periodicity of the crystal lattice.
- 11) The ability of a material to prevent or retard the propagation of fire through either restraining the chemical reactions responsible for the flame or creating a surface preventive layer.
- 12) A type of welding defect that occurs in rolled steel plates, the cracking has a terraced appearance, it occurs in T-butt and fillet welds normally observed in the parent metal parallel to the weld fusion boundary and the plate surface.
- 13) A novel metal forming technology that offers near net-shaped metal components of complex geometries.
- 14) Materials that possess particular native properties and functions of their own.
- 15) Composite materials rely on carbon fiber to provide strength and stiffness while the polymer provides a cohesive matrix to protect and hold the fibers together and provides some toughness.

- 16) Linear polymer, made from wood-derived fiber (pulp) that has been defibrated to the nano level of several hundredths of a micron and smaller, which exhibits high stiffness and strength due to the extensive inter- and intramolecular hydrogen bonds between the molecules.
- 17) A materials processing technique in which high pressure is applied to metal powder in a sealed elastomer container shaped for the application.

7. Complete the paragraphs using the terms from task 5 of this unit. In some sentences, the plural form is required. In each paragraph, the same word is missing.

- 1) _____ are among the most frequently used sensing elements in “smart composites”. These are preferably embedded in the composite because this generates a more reliable sensor signal output; however, some techniques allow surface attachment while maintaining sensor output quality. The smaller the diameter of the _____, the better is its integration into the composite, with diameters $\leq 125 \mu\text{m}$ being ideal.
- 2) _____ is a relatively new technology for metal forming. Different from the conventional metal forming technologies which use either solid metals (solid-state processing) or liquid metals (casting) as starting materials, _____ deals with semisolid slurries, in which non-dendritic solid particles are dispersed in a liquid matrix. Semisolid metal slurries exhibit distinctive rheological characteristics: the steady-state behavior is pseudoplastic (or shear thinning), while the transient state behavior is thixotropic. All the currently available technologies for _____ have been developed based on those unique rheological properties, which in turn originate from their non-dendritic microstructures.
- 3) The _____ is the component that holds the functional filler together to form the bulk of the composite, so all types of concrete can be used as a _____ for self-sensing concrete. Here, concrete is a generalized concept that includes concrete (containing coarse and fine aggregates), mortar (containing fine aggregates), and paste (containing no aggregate, whether coarse or fine). In previous studies, typical Portland cement concrete was most frequently used. The _____ in the deformable porous media are made up of either one single mineral or several minerals. For example, quartz sandstones are mainly composed of quartz (SiO_2), while greywacke is composed of quartz, feldspar, mica, clay, and other minerals.
- 4) The _____ was examined in the course of three series of tests. In stage II it is considerably lower than the flexural strength in the field because the direction of reinforcement differs from the direction in which stress is applied. This result is not specific to pre-cast slabs, it is also true for site-mixed concrete slabs. If pre-cast slabs joints are used in the area being twisted, there is a clear reduction in the _____ and in the twisting moment which can be absorbed. The horizontal joint between the pre-

cast slabs and the site-mixed concrete has no influence. Favorable twisting moments may be taken into account in the design if there are no pre-cast slab joints in the twisting area.

- 5) _____ has been practiced for over four decades and is playing an important role in the modern manufacturing industry and the economy. While laser cutting, welding, marking, and drilling processes have reached maturity with wide industrial acceptance, new developments in recent years in additive manufacturing and micro-fabrication/nanofabrication have enabled new capabilities that lasers can bring to the manufacturing industry. Research in new technology development, optimization, modeling/simulation, and understanding the basic science (beam/ material interactions, material characteristics, and new material properties generated by lasers) involved in laser processing plays a critical role in advancing _____ science and technology.
- 6) _____ are found in many applications and, in the form of thick films, are at the heart of many microsystems and micro-electromechanical systems (MEMS). Microsystems and MEMS are functional devices that can act upon their surroundings and/or detect the stimuli around them. In such devices, it is the active material that imparts the _____ behavior to the device as a whole, while the exact response of the device is determined by the structure and how the _____ is integrated with the rest of the structure. Without the structure, the _____ is little more than scientific curiosity; together, they can be engineered for a range of applications. A variety of _____ is developed in the form of bulk ceramics and/or bulk single crystals. Thin films of these _____ are essential for the present and future electronic components and/or MEMS. However, a reliable fabrication process for functional thin films in production has not been fully established yet.
- 7) Considering thermosets, _____ is an important feature that decides its high-temperature applications. For conventional epoxies, their combustible essence limited their advanced high flame resistance applications. Materials containing halogens are widely used to improve the _____ of epoxy resins. However, due to some environmental considerations, the usage of halogenated compounds is limited. To substitute halogen-based _____, more studies have been carried out concerning halogen-free high flame-resistant epoxies. As a result, outstanding _____ of epoxy polymer is achieved through the incorporation of heteroatoms like phosphorus, silicon, and boron.
- 8) _____ are interesting both because of their novel behavior and because of enhancements in other material properties that are related to Poisson's ratio. For example, hardness can be increased in an _____. When an object hits an _____ and compresses it in one direction, the _____ also contracts laterally — material 'ows' into the vicinity of the impact. This creates an area of denser material, which is resistant

to indentation. Examples include electrically (semi)conducting polymers, materials that contract when heated, and those that expand when subjected to hydrostatic pressure.

- 9) _____ processes, namely, grinding, are performed by abrasive tools. Abrasive tool, used for _____, has many different parameters, such as wheel size, abrasive material, binding material, grain. It is generally thought that in _____, high energy is consumed. However, the energy per unit manufactured is determined by the energy consumed and the processing time.
- 10) _____ can occur beneath the weld especially in rolled steel plate which has poor through-thickness ductility. The principal distinguishing feature of _____ is that it occurs in T-butt and fillet welds normally observed in the parent metal parallel to the weld fusion boundary and the plate surface. The cracks can appear at the toe or root of the weld but are always associated with points of high-stress concentration.
- 11) _____ are composite materials that rely on the carbon fiber to provide the strength and stiffness while the polymer provides a cohesive matrix to protect and hold the fibers together and provides some toughness. _____ are gaining popularity in the luxury, sports segment for mass reduction. These materials, which may also be reinforced with glass or other fibers, have high-price tags and are more suited for lower volume manufacturing as a result of molding cycle times. New technology in reducing fiber cost and panel processing has been in the news in the past few years and the increased implementation is good indicator progress is being made.
- 12) Incorporation of plant _____ in PLA by melt mixing. Plant _____ extracted from highly purified cellulose were lyophilized and dispersed in water using the application of ultrasound. They were then centrifuged at 12,500 rpm, 15 °C, and 20 min, the water was removed from the supernatant through decanting, and the water was replaced by acetone, which was replaced later using the same method by chloroform (solvent used for PLA). This cycle was repeated four times to ensure the complete substitution of the solvent and, therefore, obtaining plant _____ disperse in the non-polar solvent chloroform. The solution of chloroform with _____ was used to dissolve the PLA pellets, so the final concentration of nanofibers with respect to the weight of PLA in the solution was set at 8%. To improve the electrospinning of the matrices, 20% polyethylene glycol and 80% PLA were added, such that both materials represent 5–6 wt% of the chloroform.
- 13) _____ is a widely used continuous casting process, producing non-ferrous alloy ingots for remelting, extrusion, and rolling. Aluminum alloys are by far the greatest tonnage _____ and the bulk of the _____ literature refers to aluminum. Magnesium _____ has been partially reviewed and contrasted to aluminum. Semi-continuous

vertical _____ remains the more common version of the process as opposed to horizontal _____. Fully continuous _____ is achieved with a flying saw below the mold cutting the ingots to the desired length.

- 14) _____ limit the efficiency of multi-crystalline silicon solar cells. Recombination through traps is more prominent in areas with a high density of _____.
- 15) _____, in which the powder is subjected to equal pressure from all directions, followed by machining, is also in general use for wear and metal forming tools. _____ is commonly used for parts that are too large to be pressed in uniaxial presses and that do not require high precision in the sintered state.
- 16) The _____ technique has been extensively applied to conventional metallic materials for corrosion protection due to some outstanding advantages over other existing coating methods. This wet-coating skill, in general, generates a layer uniformly covering the surface of components even with irregular shapes, such as porous, hollow, and screwed structures, which is not possible for some line-of-sight techniques, such as plasma spray, RF sputtering, chemical/physical evaporation deposition, etc. _____ are more adhesive due to the presence of chemical bonds and an intermediate layer between the coating and underlying metal. This technique is easy to operate, the processing time is short, raw chemicals used for bath solutions are cheap and no specific equipment or conditions are required, which is favorable for industrial manufacturing. One critical limitation of _____ is their relatively low toughness/wear resistance and durability, which leads to defects and damage, which decreases the protectiveness, which relies heavily on the integrity of a coating.
- 17) _____ is parent to a family of processes whereby a solid material is deposited from vapor by a chemical reaction occurring on or in the vicinity of a normally heated substrate surface. The resulting solid material is in the form of a thin film, powder, or single crystal. By varying experimental conditions, including substrate material, substrate temperature, and composition of the reaction gas mixture, total pressure gas flows, etc., materials with a wide range of physical, tribological, and chemical properties can be grown. _____ is one of the most common processes used to coat almost any metallic or ceramic compound, including elements, metals, and their alloys and intermetallic compounds.

8. Make words or word combinations by putting the entangled letters in the correct order.

- | | |
|------------------------------|----------------------------------|
| 1) liarselironyctzat | 10) adecciihlsirctlngt |
| 2) nelolseleuoabfncir | 11) eutmiacaletxrai |
| 3) edreyranmclafta | 12) ceenrycbfearroimolorbnrfdpei |
| 4) rilobcftaepi | 13) ryoiphoxtt |
| 5) ynatepirnoto | 14) easibsgfrl |
| 6) ooergicsinlanoatccminhevc | 15) lornasiotamcpoedpviceih |
| 7) ecfottnmseycrriialp | 16) soeuhngst |
| 8) itmaaimelrartx | 17) nrsypoatio |
| 9) giaznr | |

9. Put the parts in order to form a sentence.

1. localized/ yielding,/ there/ deformation/ strength,/ deformation:/ three/ deformation/ stages of/ are/ uniform/ tensile/ and postuniform,/ effectively/ to fracture/ to the ultimate/
2. Poisson's ratio/ fatter/ by the manner/ in a negative/ get/resulting/ differ/ from/ materials/ respond to/ in which/ materials/ they/ conventional/ stretching;/ they/ auxetic/ when/ stretched,/ tend to
3. such as;/ profile/ crystallite size,/ and dislocation/ density/ internal/ estimated/ number of crystallite/ imperfection/ by using/ were/ the line/ residual/ microstrain,/ the crystal/ analysis/ technique/ stress,/ parameters/
4. have/ and a proper/ for different/ materials,/ characteristics/ the wavelength/ with/ material/ should be/ optical/ solid/ different/ fibers/ optical/ for/ core/ core/ and power/ of light/ chosen/ sources/ and physical/
5. of heating/ air/ above/ steel/ the recrystallization/ followed by/ temperature,/ at that/ a process/ cold-worked/ is/ annealing/ cooling/ normal/ temperature/ for a predetermined/ holding/ and then/ recrystallization/ time/
6. volume of/ potentially/ possible/ the largest/ by distributing/ energy/ over/ material/ ductile/ absorption/ material/ toughness/ in any/ is achieved/
7. are widely/ and precision/ in high/ and anti-shock/ because/ mechatronic/ due to/ reducers/ machinery/ multiple/ have/ rigidity/ cycloid/ they/ characteristics/ used/ torsional/ contacts/ high/ performance/
8. sharp/ tools/ carried out/ machining/ can be/ operations/ the cutting/ all/ high-speed/ customary/ as long as/ are very/
9. materials/ material/ characteristics/ needs/ of optimum/ approaches,/ should/ the achievement/ systematic/ composite/ allow/ engineering/ and interactive/ which/

10. with/ of materials/ at elevated/ attempts/ anisotropy/ magnetocrystalline/ also/ temperature/ large/ the development/ this property/ to retain/
11. is produced/ foil/ tens of/ by single-roller/ the brazing/ chamber/ in a vacuum/ with several/ melt/ micrometers/ spinning/
12. electrical,/ materials/ materials/ for their/ capacity,/ stimuli/ of their/ functional/ the nature/ response to/ optical/ structural/ magnetic,/ or chemical/ for/ load-bearing/ are selected/
13. vapor/ a process/ on the surface/ films/ the vapor/ by/ are deposited/ from/ phase/ the decomposition/ deposition/ is/ of chemicals/ chemical/ in which/ of a substrate/ of materials/
14. consumption/ the efficiency/ a viable/ researchers/ to make/ of energy/ alternative/ on optimizing/ in order/ bioplastics/ of the processes/ are working/ in terms/
15. are its/ nanofibers/ other/ compared to/ strength/ characteristics/ natural/ properties/ fibers,/ the birefringence/ and synthetic/ in addition/ to the main/ high/ and biodegradability/ of cellulose/
16. methods/ of surface/cost-effective/ conversion/ of the most/ are/ coatings/ or surface/ chemical/ one/ substrates/ modification/ of steel/ passivation/

10. Find 19 hidden terms in the word search puzzle. The terms are directed forward →, back ←, down ↓, up ↑ and diagonally ↘, ↙, ↖, ↗. There are terms made up of one, two, or more words. The words do not belong together, but they are fused in the puzzle. One of the terms is marked.

f	h	y	p	o	r	t	o	s	i	n	a	a	l	l	o	y	s	t
c	i	u	y	s	e	a	n	o	i	t	a	m	r	o	f	e	d	y
m	i	b	d	t	h	n	r	t	t	a	e	h	y	h	a	f	c	t
g	a	t	r	i	i	a	a	e	o	n	w	p	v	u	o	n	n	v
n	l	t	s	e	l	d	p	n	a	u	o	f	x	o	a	a	s	n
o	r	a	r	a	g	o	i	e	o	r	g	e	d	d	l	w	e	y
i	f	e	t	i	l	l	s	g	t	m	t	h	r	p	c	p	p	a
t	y	l	b	e	x	p	a	o	i	i	a	a	n	o	o	o	e	c
a	r	k	o	i	m	m	i	s	c	r	t	t	m	e	r	t	i	t
z	t	v	d	w	f	t	a	m	s	e	g	p	e	t	s	t	c	n
i	s	g	z	h	n	l	a	t	r	p	o	n	o	r	s	s	o	e
l	i	x	n	a	s	t	a	e	e	s	r	x	i	a	i	y	l	v
l	m	e	n	i	e	i	m	c	i	r	i	o	l	t	t	a	d	l
a	e	e	n	r	z	a	l	t	i	h	i	p	c	p	s	i	l	o
t	h	m	i	o	l	a	e	g	t	t	o	a	r	e	h	i	m	s
s	c	a	l	f	z	j	r	n	n	i	p	i	l	t	s	a	w	e
y	l	a	m	s	a	l	p	b	b	e	b	o	e	f	a	s	s	t
r	q	g	n	i	r	a	e	t	r	a	l	l	e	m	a	l	j	e
c	d	i	r	e	c	t	c	h	i	l	l	c	a	s	t	i	n	g

11. Reading and discussion.

a) Read the text and answer the questions:

- 1) Which departments' researchers have collaborated on the development of a new class of materials?
- 2) What is the main application intended for new two-dimensional polymers?
- 3) What was the aim of the joint work of Lustig and Strawhecker?
- 4) What has the main method been used by researchers to test new material and compare it with characteristics of the known materials?
- 5) What improved properties were found during the study compared to one-dimensional polymer and aramid fiber?

2D polymer discovery

Source link: <https://www.sciencedaily.com/releases/2021/02/210225113249.htm>

Date: February 25, 2021

Source: U.S. Army Research Laboratory

Army researchers reached a breakthrough in the nascent science of two-dimensional polymers thanks to a collaborative program that enlists the help of lead scientists and engineers across academia known as joint faculty appointments.

Researchers from the U.S. Army Combat Capabilities Development Command, Army Research Laboratory partnered with Prof. Steve Lustig, a joint faculty appointment at Northeastern University, to accelerate the development of 2D polymers for military applications.

According to Wetzel, research area leader for Soldier Materials at the laboratory, 2D polymers have a very repeatable, symmetric pattern akin to "chicken wire," which offers access to more structural enhancements compared to one-dimensional, linear polymers like Kevlar.

To gauge the full potential of these materials, Army researchers have started to computationally design 2D polymers in the hopes that they may develop a superior alternative to conventional aramid fibers for applications such as armor and fire-resistant clothing.

Prof. Steve Lustig, a joint faculty appointment at Northeastern University, uses his industry experience with DuPont to help Army researchers calculate the environmental durability of simulated 2D polymers.

To properly create a 2D polymer that can withstand real-world conditions, Army researchers sought the aid of Lustig, who previously worked at DuPont Central Research & Development for over two decades before he became an associate professor with tenure at Northeastern University.

"The idea of the 2D polymer project is to make a 2D version of Kevlar," Lustig said. "I had over a decade of experience working with the Kevlar business in various aspects of liquid crystalline polymer polymerization, processing, and properties. The ARL team believed that my background would be helpful."

Lustig explained that he had first learned about the laboratory in the mid-2000s when he came in contact with Dr. Kenneth Strawhecker, an Army scientist who had reached out to DuPont in search of industry collaborations.

At the time, Lustig worked as a lead scientist in DuPont's polymer physics group and specialized in the development of novel tools for statistical mechanics, statistical thermodynamics, and molecular simulations. In addition to his expertise on the computational side of industrial research, he also conducted experiments in chemical synthesis, polymer processing, polymer material property characterization, and atomic force microscopy.

Lustig and Strawhecker began a series of informal collaborations that focused on the use of atomic force microscopy to understand not only the structure of Kevlar materials but also their response to tensile strain and bending mechanics.

Even after Lustig left DuPont in 2016, he continued his collaborations with the laboratory as a visiting scientist. Shortly after one of his seminar presentations at the lab, he met Wetzel, who immediately recognized the value of Lustig's industry experience.

Throughout his continued interaction with Strawhecker and Wetzel, Lustig obtained the opportunity to become an ARL Joint Faculty Appointment after he joined the Department of Chemical Engineering at Northeastern University.

Due to his proximity to ARL's Northeast campus, both Strawhecker and Wetzel saw Lustig as a top candidate for the position.

"The ARL Open Campus Initiative provides a way to tap into outside expertise that may not exist within our laboratory," Wetzel said. "The joint faculty appointment is a new construct within Open Campus that has only existed for a few years, but we were able to integrate an expert with years of experience at DuPont into our research program thanks to this mechanism."

According to Wetzel, Lustig's long history with high-performance fiber development projects at DuPont provided Army researchers with access to unique modeling capabilities as well as invaluable guidance on the methods and techniques that would enhance the stability of their conceptual 2D polymers.

As a joint faculty appointment, Lustig analyzed the environmental durability of the lab's 2D polymer designs and ran computer simulations that determined how well they endure extreme conditions such as intense heat.

Through these computer simulations, the researchers compared the thermal stability of the 1D polymer Kevlar, a 2D polymer called an amide covalent organic framework, known as amCOF, and a hypothetical 2D polymer designed by the laboratory called graphamid.

"We performed a series of very accurate, high-level quantum mechanical calculations called *ab initio* molecular dynamics and studied the changes in the structure

between the three molecules we looked at," Lustig said. "Once we confirmed that our method could accurately describe a well-known molecule like Kevlar, we could apply it to molecules we didn't know like graphamid and make accurate predictions about their behavior and properties."

The results of the comparison study showed that graphamid could potentially withstand temperatures as high as 700 degrees Celsius, which exceeded the limits of both Kevlar and the amCOF material.

b) Determine which of the following statements match the content of the text (True), which do not match (False), and what the text does not say (Not Stated).

- 1) 2D polymers have been studied very seriously from a synthetic viewpoint for about 50 years.
- 2) The idea of the 2D polymer project is to make a 2D version of Kevlar.
- 3) Lustig worked as a lead scientist in DuPont's polymer physics group and specialized in the development of novel tools for statistical mechanics, statistical thermodynamics, and molecular simulations.
- 4) Lustig obtained the opportunity to become an ARL Joint Faculty Appointment after he joined the Department of Chemical Engineering at Northeastern University.
- 5) The high-level quantum mechanical calculations allowed exactly to assume the properties of the new material of the unknown structure.

c) Visit one of the websites <https://academic.oup.com/>, <http://abc-chemistry.org/>, <http://www-jmg.ch.cam.ac.uk/data/c2k/cj/> or any other website publishing research articles in Chemistry, choose an article, read and summarize its content using the plan and useful phrases in the Appendix. The length of the summary should be about 10 % of the original text.

Unit 7. Metallurgical Engineering

1. Read the text about one of the most important industries. What are its foundation and significance?

Metallurgical engineering is the field of engineering dedicated to working with metals. It encompasses the extraction of metals from the earth, refining metal ores, and the design and production of materials made from mixtures of metals, called metal alloys. It is enormously important to fields such as manufacturing and construction, as well as to a vast array of consumer goods with metal components.

This field of engineering is commonly divided into two areas, extractive and physical metallurgy. In extractive metallurgy, metallurgical engineering is used to extract and refine metals mined from the earth. Metals are almost always found mixed with other materials in mineral deposits called ores and are frequently in chemical compounds rather than in pure elemental form. Before these metals can be used, they must first be removed from the ore.

This can be done with several different methods, depending on the ore in question. Ores can be heated to cause physical changes and chemical reactions in the ore. Chemical agents can be applied to cause chemical reactions in the compounds containing the metal. Ores can be dissolved in water heated until they are molten so that the metal can be isolated through electrical processes. Once the metal is not chemically joined with other elements, it is then refined to physically purify it. These methods depend on knowledge of metallurgical engineering.

Once metals have been obtained from the environment through extractive metallurgy, physical metallurgy is what puts them to use. One of the primary applications of metallurgical engineering is the creation of metal alloys by combining a metal with other metals or nonmetal materials. Alloys can have properties differing from their constituent parts, and a huge variety of alloys have been created to provide materials for different tasks. Most commonly, the constituent substances of an alloy are mixed by heating them enough that they melt and then mixing them and allowing the mixture to cool and solidify. Other means of alloying materials are also possible, such as mixing them in solid powdered form and then subjecting them to great heat and pressure to combine them.

The alloy can then be subjected to many different treatment processes that alter its mechanical properties without changing its chemical composition. These processes can be mechanical, altering the crystalline structure of the alloy. They can also involve

heating the alloy, as processes such as holding an alloy at a high temperature for extended periods or heating it and then rapidly cooling it off again by immersing it in cold water or oil can also affect the crystalline structure in which the atoms of the alloy are arranged. Metallurgical engineering applies scientific knowledge of the characteristics of different mixtures of substances and the physical effects of different treatments to devise a production process to create an alloy that is best suited to a given application.

Thus, metallurgical engineering is at the center of metals production industries such as steelmaking. It is very important to related areas such as building construction, the design of vehicles such as automobiles and airplanes, and civil engineering projects such as bridges. Additionally, metallurgical engineering is essential to the industrial manufacture of many capital and consumer goods.

The oldest known examples of metalworking date back to about 7,000 BC, when humans began using primitive weapons and tools made of copper. By 6,000 BC, humans were using fire to smelt ores containing copper to make purer metals. The first known man-made alloys date back to 3,800 BC when metalworkers in the Middle East began alloying tin and copper to create bronze, a much more effective material for weapons and tools that would radically shape the development of civilization. People in different parts of the world discovered basic metallurgical processes independently. These events predate the idea of engineering as a specialized professional or scientific discipline by many thousands of years, of course, but the essential core of metallurgical engineering — using knowledge of metals to extract, shape, and transform them for human use — is present.

Source link: <https://www.wisegeek.com/what-is-metallurgical-engineering.htm>

2. Match the terms (1-32), transcriptions (a-ff), and translations (i-xxxii).

1) abrasion resistance	a) [ˈi:kə(v)ˈpɪk(ə)ldˈsɜːfɪs]	i. литьё в песчаные формы
2) advanced high-strength steel (AHSS)	b) [ˌmetəˈlɔːgrəfi]	ii. флюсующая добавка
3) agglomerate	c) [ˈlɪθɑːdʒ]	iii. нейтронография
4) alloyage	d) [ˈsɪndə]	iv. пирометаллургия
5) annealing	e) [ˌferəvˈæləɪ]	v. экологичное травление поверхности
6) austempered ductile iron (ADI)	f) [rɪˈfræktərɪˈlaɪnɪŋ]	vi. свинцовый глёт (литарг)
7) babbit	g) [ˈsteɪnlɪsˈstiːl]	vii. гетит

8) calcination	h) [ˈɔ:sˈtempəd ˈdʌktɑɪləɪən]	viii. аурипигмент; серный мышьяк
9) cementation	i) [ˈhaɪdrə(v)ˈmetə,lɜ:dʒɪ]	ix. шлак
10) cinder	j) [məʊld]	x. нержавеющая сталь
11) dust catcher	k) [ˈɔ:pɪmənt]	xi. спекание
12) Eco Pickled Surface (EPS)	l) [ˈkælsɪˈneɪf(ə)n]	xii. литейная форма
13) ferroalloy	m) [ˈkwentʃɪŋ]	xiii. легирование, сплавление
14) fluxing agent	n) [ˈtwi:ʃeə]	xiv. нитроцементация
15) fusion	o) [ˈnaɪtrə(v)ˈkɑ:bjʊraɪzɪŋ]	xv. агломерат
16) goethite	p) [slæg]	xvi. фурма
17) hydrometallurgy	q) [ˈsfæləˌraɪt]	xvii. износостойкость, абразивостойкость
18) litharge	r) [ˈnju:trəndɪˈfrækf(ə)n]	xviii. окалина, огарок
19) metallography	s) [ˈdʌstˈkætfə]	xix. сфалерит; цинковая обманка
20) mold	t) [əˈbreɪz(ə)nriˈzɪstəns]	xx. цементирование
21) neutron diffraction (ND)	u) [ˈsi:mənˈteɪf(ə)n]	xxi. огнеупорная футеровка
22) nitrocarburizing	v) [ˈflæksɪŋˈeɪdʒ(ə)nt]	xxii. баббит
23) orpiment	w) [ˈgəʊθaɪt]	xxiii. шлаковик, пылеуловитель
24) pyrometallurgy	x) [ˈfju:z(ə)n]	xxiv. аустенитный высокопрочный чугун
25) quenching	y) [əˈni:lɪŋ]	xxv. плав, расплавление
26) refractory lining	z) [ˈbæbɪt]	xxvi. обжиг, прокаливание
27) sand casting	aa) [ˈsændˈkɑ:stɪŋ]	xxvii. выжигание, обжиг
28) sintering	bb) [ˌpaɪrəʊməˈtælədʒɪ]	xxviii. металлография
29) slag	cc) [əˈlɒndʒ]	xxix. гидрометаллургия
30) sphalerite	dd) [ədˈvɑ:nst ˌhaɪˈstreŋθ ˈsti:l]	xxx. ферросплав
31) stainless steel	ee) [əˈglɒm(ə)rɪt]	xxxi. прогрессивные стали повышенной прочности
32) tuyere	ff) [ˈsɪntəɪɪŋ]	xxxii. мгновенное охлаждение

3. For each definition (a-ff) choose a suitable term from task 2 (1-32).

- a) A refractory mass applied to the screen tubes to increase the temperature in the boiler combustion chamber.
- b) An ore that is the chief source of zinc; consists largely of zinc sulfide in crystalline form.
- c) Anti-friction alloy based on tin or lead, for use as a bed, poured or sprayed on the case for plain bearings.
- d) The thermal treatment of minerals and metallurgical ores and concentrates to bring about physical and chemical transformations in the materials to enable recovery of valuable metals.
- e) A mass of angular volcanic fragments united by heat; distinguished from the conglomerate.
- f) A scale thrown off in forging metal.
- g) The act of melting or liquifying something by heating it; the state of being melted or dissolved by heat; a state of fluidity or flowing in consequence of heat.
- h) A very versatile process and can produce castings of extreme complexity in a wide range of aluminum alloys.
- i) A nozzle or similar fixture through which the blast is delivered to the interior of a blast furnace, or the fire of a forge.
- j) A toxic solid formed from the oxidization of lead in air and used as a pigment.
- k) A process applied to hot-rolled sheet steel to remove all surface oxides (mill scale) and clean the steel surface.
- l) A very similar process to carburizing, involving the simultaneous diffusion of both carbon and nitrogen into austenite in low carbon steel.
- m) The ability of a surface to resist being worn away by rubbing or friction.
- n) A heat treatment that alters a material to increase its ductility and to make it more workable. It involves heating material to above its critical temperature, maintaining a suitable temperature, and then cooling.
- o) A red or yellow or brown iron-bearing oxide mineral found in soil and other low-temperature environments; an oxide of iron that is a common constituent of rust.
- p) A powerful and relatively easy approach to characterize metallic samples getting as much information as possible: trying to understand the nature of metals by microstructural features visible by an optical microscope.
- q) The rapid cooling of a hot metal object, by placing it in a liquid, to harden it.
- r) Steel containing chromium that makes it resistant to corrosion.
- s) Any alloy of iron and another metal, especially one of silicon, manganese, chromium, vanadium, tungsten, titanium, and molybdenum; used in the production of specialist steels as they have a lower melting point than pure metal.

- t) The act or art of making a mixture or metallic solid solution composed of two or more elements.
- u) A substance added to molten metals to bond with impurities that can then be readily removed.
- v) A crystallographic method used to determine the atomic and/or magnetic structure of materials.
- w) Forming a coherent bonded mass by heating metal powders without melting, used mostly in powder metallurgy.
- x) A class of steel with multiphase microstructure (dual-phase steel, steel with phase-transformation induced plasticity, etc) that metallurgical features associated with the thermo-mechanical processing.
- y) The field of extractive metallurgy involving the use of aqueous chemistry for the recovery of metals from ores concentrates, and recycled or residual materials.
- z) A form of ductile iron that enjoys high strength and ductility as a result of its microstructure controlled through heat treatment.
- aa) A process of heating a substance under controlled temperature and in a controlled environment without melting to drive off water etc.
- bb) High tonnage device that is widely used to separate a mixture of dusts from blast furnace top gas flow.
- cc) Arsenic trisulphide, occurring naturally in crystals or massive deposits, formerly used as a dye or pigment.
- dd) A metallurgical coating process in which iron or steel is immersed in a powder of another metal, such as zinc, chromium, or aluminum, and heated to a temperature below the melting point of either.
- ee) The system of the elements forming the working cavity, by pouring a molten metal casting is formed.
- ff) A nonmetallic product resulting from the interaction of flux and impurities in the smelting and refining of metals.

4. Complete the paragraphs using the terms studied in this unit (task 2). In some sentences the plural form is required. In each paragraph, the same word is missing.

- 1) The traditional method of solidifying the metal is to cast it into _____ where it is allowed to cool slowly. The _____ may simply be a casting bed of metal fines shaped to form _____. Alternatively, cast iron _____ may be used. The casting bed is arranged on an incline so that metal from the ladle passes down a runner from where it cascades into the _____. Once cast into the _____, the metal is allowed to cool. It may be allowed to cool naturally, or it may be sprayed with water to cool it more

rapidly. A more sophisticated casting system employs cast iron _____ arranged in a casting line, which moves past the ladle placed in a tilting station.

- 2) _____ is the greatest gift of metallurgy to humankind. The English insists on unalloyed pleasures, thereby implying that the sensation of pleasure must be pure and not admixed with other emotions, exactly the opposite rules in metallurgy, where pure metals have few uses but lot more upon _____. The power of this idea of _____ is not confined to metals. The same principle of _____ applies in polymers and ceramics. It can be carried further by mixing two classes of materials to create a variety of composites.
- 3) _____ is also important for the evaluation of problems relating to the authenticity of artefacts and may form an essential component of investigations which seek to understand how artefacts are fabricated and what cultural decisions have been made in how the materials chosen have impacted the way the materials are worked. _____ specimens from the cross-sectional areas of the drill pipe (i.e., full wall thickness of the drill pipe) were prepared (as per the standard procedure) and examined in SEM. Both surfaces of the drill pipe did not exhibit any coating.
- 4) _____ can be used for the majority of metals. Even highly reactive magnesium is _____ provided care is taken and the correct materials used by adding what are called inhibitors into the sand. _____ inevitably have a slow cooling rate because of the large insulating mass of sand surrounding the liquid metal as it cools. Grain sizes and dendrite arm spacings tend to be larger than in equivalent section sizes in die-castings. _____ can produce aluminum blocks like those of cast iron. In comparison with cast iron, _____ of aluminum is not so easy because oxide entrapment and shrinkage defects are likely to occur. Cast iron does not cause this type of problem. Expansion during solidification due to the formation of graphite has made cast iron ideal for the economical production of shrinkage-free castings. _____ using resin bonded sand is normally used for aluminum.
- 5) _____ is a branch of extractive metallurgy. _____ treatment may produce saleable products such as pure metals, or intermediate compounds or alloys, suitable as feed for further processing. Examples of elements extracted by _____ processes include the oxides of less reactive elements like Fe, Cu, Zn, Cr, Sn, or Mn. _____ processes are generally grouped into one or more of the following categories: calcining, roasting, smelting, refining. Most _____ processes require energy input to sustain the temperature at which the process takes place.
- 6) The FTS activity and product selectivity were evaluated using a fixed bed tubular _____ micro-reactor of 20 mm internal diameter. Three mass flow controllers were used to control the flow rate of the inlet gases (CO, H₂ and N₂ with a purity of 99.999%), and a mechanical back-pressure regulator was used to control the pressure

of the system. Three thermocouples were located in the catalyst bed for monitoring the inlet, outlet, and bed temperatures.

- 7) A method of smelting a gold-rich source material in a crucible comprises i) adding a _____ to the crucible; ii) heating the _____ in the crucible to provide an initial molten fluid pool of _____ in the crucible; iii) adding gold-rich source material to the molten pool of _____; iv) pouring out of the molten contents of the crucible with separation of slag to form a precious metal ingot.
- 8) Pyrometallurgy, _____, and bioleaching are the methods widely used for metal recovery from solid waste. Both _____ and pyrometallurgy are conducive to the rapid and efficient attainment of metal mixtures, resulting from high temperatures and highly acidic or alkaline conditions, respectively. However, these two processes generate environmental pollutants, such as furans, dioxins, and highly acidic wastewater. _____ is a method for obtaining metals from their ores. It is a technique within the field of extractive metallurgy involving the use of aqueous chemistry for the recovery of metals from ores, concentrates, and recycled or residual materials. The complement to _____ is pyrometallurgy, which is usually older technology. _____ is typically divided into three general areas: leaching, solution concentration, and purification, and metal recovery.
- 9) In the next section, _____ as a kind of hybrid process will be introduced. _____ is also known as ferritic-_____, or cyaniding. It is a modified nitriding process in which a gas containing carbon is added to the ammonia atmosphere. Steels held at high temperatures in this gaseous atmosphere absorb carbon and nitrogen simultaneously, at a temperature around 560 °C.
- 10) _____, an alloy of iron (less than 50 percent) and one or more other metals, is important as a source of various metallic elements in the production of alloy steels. The principal _____ are ferromanganese, ferrochromium, ferromolybdenum, ferrotitanium, ferrovanadium, ferrosilicon, ferroboron, and ferrophosphorus. _____ are prepared from charges of the nonferrous metal ore, iron or iron ore, coke, or coal, and flux by treatment at high temperature in submerged-arc electric furnaces. An aluminothermic reduction process is used for making ferrovanadium, ferrotitanium, and ferroniobium.
- 11) The fundamental aspects of _____ and its use in the study of materials have been covered in detail in several excellent books which should be consulted for details. Neutrons interact with matter in a variety of ways which make _____ both similar to and yet different from X-ray diffraction. _____ is an alternative to XRD and most of the drawbacks to the use of X-rays have been resolved. The penetrating power of neutrons enables through-thickness stress profiling without any material removal up to several millimeters based on materials. The stress determination in

_____ is based on the same principle as XRD. Lower spatial resolution and challenging experimental procedures limit its usage.

- 12) _____ is the process of extracting the metals from a solution based on the electrochemical reaction between the cementing metal and the ion of the precipitated metal. The thermodynamic feasibility of _____ is determined from the ratio of the values of the electrode potentials. The electrode potential of the displacing metal must be more negative than that of the displaced metal. The precipitation of the metal is accompanied obviously by a change of its concentration of the solution, and consequently, of its potential. When the equilibrium values are reached, the process stops.
- 13) _____ is particularly dependent on good curing but also relies upon other factors including materials and surface finishing, aggregate hardness, mix proportions, aggregate/paste bond, and placing and compaction. SCMs can have effects on _____ of concrete. There are a limited number of studies on the _____ of GGBFS included concretes in the literature. It is possible to increase the _____ of concrete by changing void content and the porosity with the addition of some of the SCMs such as GGBFS, FA, SF, and superplasticizers. _____ is an important property for concrete uses in pavements as it is subjected to dynamic loading from traffic. It is affected by concrete strength, surface finishing, and mainly the properties of the aggregates. The _____ seems not to be affected by the use of RA in concrete mixes.
- 14) _____ is an important step in the manufacture of cadmium pigments to achieve particular pigmentary characteristics. In the production of cadmium pigments, the temperature of _____, residence time and calcining atmosphere influence the color and pigment texture. Lower _____ temperature results in lighter and brighter pigment shade but with less strength whereas higher temperature results in deeper shade. This process plays a vital role for the titanium dioxide pigments as well.
- 15) _____ welding is a joining process that uses _____ of the base metal to make the weld. It is mostly used to join materials of similar compositions and melting points. _____ welding is of the greatest importance in the fabrication of engineering structures. There are many ways in which _____ welding can be carried out, but all of them involve the deposition of a small amount of molten steel between the components to be joined or coated. When the steel solidifies, it welds the components together.
- 16) _____ materials, which include ceramic refractories and nonfired heat-resistant concretes, have a very short lifespan during the turnaround time measured in years and sometimes months. Therefore, increasing the service life of thermal generating units by 1.5-2 times will bring significant economic benefits. The main factor that determines the durability of _____ materials is the thermal resistance. Today the

_____ is frequently maintained and improved by adding various elements such as titania. All of these developments have helped result in lower iron costs, increased blast furnace campaign life, and improved working conditions for operational and maintenance personnel.

- 17) _____ is the most economic and widely used agglomeration process to prepare iron ore fines for blast furnace use. The key steps of the _____ process are granulation and thermal densification.
- 18) The _____ in Peirce-Smith converters are carbon, steel, or stainless steel pipes that are embedded in the converter refractory. They are joined to a gas distribution 'bustle pipe', which is affixed along the length of the converter and connected through a rotatable seal to a blast supply flue.
- 19) Orthorhombic _____ (α -FeOOH) is a common constituent of soils and sediments. _____ is antiferromagnetic with a Néel temperature of 120°C, but it has a weak superimposed parasitic ferromagnetism that probably arises from a defect moment as in hematite, with which it is often intergrown. Acicular _____ has also been reported as the main constituent of layered _____ coatings. _____ in these coatings and infillings seems to have a relatively high degree of aluminum substitution, corroborated by analyses for similar coatings with a palisade internal fabric.
- 20) _____, As_2S_3 , is a common monoclinic arsenic sulfide mineral. It has a Mohs hardness of 1.5 to 2 and a specific gravity of 3.49. It melts at 300 °C to 325 °C. Optically it is biaxial with refractive indices of $a=2.4$, $b=2.81$, $g=3.02$. _____ is an orange to a yellow mineral that is found worldwide and occurs as a sublimation product in volcanic fumaroles, low-temperature hydrothermal veins, hot springs, and as a byproduct of the decay of another arsenic mineral, realgar. It is often found in association with realgar. It takes its name from the Latin auripigmentum because of its deep yellow color. In _____, molecular units are present in chain form and connected by bridging S atoms and cross-linked by van der Waals attraction forces.
- 21) _____ are typically found near volcanic vents and within volcanic conduits, where they may be associated with pyroclastic or intrusive volcanic breccias. Older publications, particularly in Scotland, referred to any coarse-grained volcanoclastic rock as '_____', which led to debris flow deposits, talus deposits, and other types of breccia being mistaken for vents. _____ are typically poorly sorted, may contain a fine ash or tuff matrix, and vary from matrix to clast support. They may be monolithologic or heterolithic, and may contain some blocks of various igneous rocks.
- 22) Lead monoxide (PbO), also known as litharge, is a yellowish orange crystalline solid used in fire assaying since the early 1900s. _____ is produced by contacting molten lead with air. Important uses of _____ are in the manufacturing of batteries,

ceramics, specialized types of glass, such as lead crystal and flint glass, in the vulcanizing of rubber, and as a paint pigment.

- 23) _____ is a zinc sulfide (ZnS) mineral that is brownish, yellowish, or black. It consists largely of zinc sulfide in crystalline form but almost always contains variable iron. When iron content is high it is an opaque black variety, marmatite. It is usually found in association with galena, pyrite, and other sulfides along with calcite, dolomite, and fluorite.
- 24) _____ developed and commercialized in the past decade are designed to help automotive companies meet lightweight requirements without compromising occupant safety requirements. These steels have an excellent combination of high strength and ductility, and hence are formable. _____ grades require special considerations and an understanding of their welding behavior for successful implementation in automotive construction. The term _____ generally refers to a wide range of steel grades that are part of the first generation of _____. While conventional HSS are principally composed of ferritic structures, the _____ are characterized by their multiphase structures where ferrite is accompanied by other phases that have a significant effect on the mechanical, forming, and even energy-absorbing properties.
- 25) Wear resistance because of the graphite and retained austenite is superior to the steel of the same hardness and components such as gears are quieter in operation. The potential of _____, which is substantially cheaper than forged steel and can be cast closer to shape than steel is usually forged, exceeds that of any other recently developed material. The most economically rewarding application for _____ is as a material for gears which can be made quieter, lighter, and cheaper than the equivalent steel gears. One disadvantage, for the highest-rated gears, is the lower fatigue strength of _____ compared with that of steel, but this is being overcome by shot peening the teeth of the gears. _____ has been used successfully for tracks for off-the-road vehicles, pump bodies, agricultural equipment, friction blocks, and drive shafts.
- 26) Unlike magnetite concentrates, hematite concentrates, especially specularite and pyrite _____, are harder, denser with smooth surfaces, and less hydrophilic. Therefore, they are usually much more difficult to pelletize and require higher bentonite dosages and firing temperatures to achieve the minimum green and fired pellet quality. _____ from coal-fired furnaces and boilers were used in _____ block from the late 1800s to World War II; conversion to gas and oil and the use of pulverized coal has virtually ended the _____ block industry. Fly ash and bottom ash, residues of pulverized-coal combustion, are used as pozzolans, aggregates, and starting materials for synthetic zeolites.

- 27) _____ is the decrease in the observed fluorescence intensity as a result of the interaction of the ground or excited states of a fluorophore with other species in solution. _____ can be divided into two broad categories: dynamic and static _____. In dynamic or collisional _____, the interaction of an excited state fluorophore with the quencher results in radiationless deactivation of the fluorophore to the ground state.
- 28) _____ is the glass-like by-product left over after a desired metal has been separated (i.e., smelted) from its raw ore. _____ is usually a mixture of metal oxides and silicon dioxide. However, _____ can contain metal sulfides and elemental metals. While _____ are generally used to remove waste in metal smelting, they can also serve other purposes, such as assisting in the temperature control of the smelting, and minimizing any re-oxidation of the final liquid metal product before the molten metal is removed from the furnace and used to make solid metal. In some smelting processes, such as ilmenite smelting to produce titanium dioxide, the _____ is the valuable product instead of the metal.
- 29) _____, is a proven, patented process to replace acid pickling of flat-rolled steel. It is used around the world to descale any hot rolled steel, including stainless. Unlike acid pickling, the _____ process is safe and completely harmless to the environment. The economics of _____ processing are more favorable than acid pickling and it produces a demonstrably superior product.
- 30) '_____'-bearing metals contain up to 90% tin with antimony, copper and in some cases lead, or up to 90% lead with antimony and tin. Their important characteristics are antiseizure properties and fatigue resistance. Both tin- and lead-based _____ are easy to cast, easy to bond to the backing, and easy to machine. They are useful for low-duty bearings made in short production runs. They have, however, been supplemented by other types of bearing for high-duty service and mass production. Often a very thin layer of pure lead bonded to the surface of stronger support material is used.
- 31) _____ of cold-worked, non-heat-treatable, wrought alloys to obtain intermediate mechanical properties (H₂ tempers) is known as partial _____ or back _____. During this process, the material undergoes recovery, partial recrystallization, or full recrystallization. Partial _____ results in improved bendability and formability compared to the alloy at a similar strength level in an H1 temper. It is important to have close control of temperature to achieve uniform and consistent mechanical properties.
- 32) The present invention concerns a recycling process for blast furnace sludge or powder from dry _____, or steelworks fine and coarse sludge, or industrial or metallurgical wastes through the combination of the process steps of ore pulp formation, ultrasound treatment, conditioning, gravimetric concentration, hydro-cycloning,

magnetic separation, flotation and drying for the recovery of carbon, that can be in the form of coke, mineral coal or charcoal, and metallic iron (Fe), iron oxides (Fe_xO_y), silica (SiO_2), calcium oxide (CaO) and zinc oxide (ZnO).

5. Make words or word combinations by putting the entangled letters in the correct order.

- | | | |
|-----------------------|-----------------------|----------------------|
| 1. psuaicklceeeecorfd | 6. acrtesthdcu | 11. otatenecinm |
| 2. ibnoruirgnzitrac | 7. unfxetalnggi | 12. hlpraietse |
| 3. gmlylauroetdhyr | 8. escbrsonitaaisnear | 13. rahtlgie |
| 4. utenctiffnriondrao | 9. uyeret | 14. gnrlnctrefaiiyor |
| 5. gneannali | 10. oalygpmyertlur | 15. teiotgeh |

6. Complete the paragraphs using the terms studied in this unit (task 2) again. In some sentences, the plural form is required. In each paragraph, the same word is missing.

- 1) _____ refers to the application of aqueous solutions for metal recovery from ores and has been practiced for copper recovery for many years. The original impetus for solution methods for copper extraction before the development of froth flotation technology was the existence of large ore bodies of low copper content which were uneconomic to work using conventional smelting methods. In principle, _____ technology for disposing of e-waste can produce wastewater that contains heavy metals that eventually transfer into the sludge, also known as e-waste sludge. As said above, the informal disposal of e-waste in family dismantling workshops and the _____ treatment of e-waste under laboratory conditions can both produce e-waste sludge.
- 2) _____ method is very similar to the X-ray method as it relies on elastic deformations within a polycrystalline material that causes changes in the spacing of the lattice planes from their stress-free condition. The application of _____ in solving engineering relevant problems has become widespread over the past two decades. The advantage of the _____ methods in comparison with the X-ray technique is its larger penetration depth. The X-ray diffraction technique has limits in measuring residual stresses through the thickness of a welded structure.
- 3) _____, hydrometallurgy, and bioleaching are the methods widely used for metal recovery from solid waste. Both hydrometallurgy and _____ are conducive to the rapid and efficient attainment of metal mixtures, resulting from high temperatures and highly acidic or alkaline conditions, respectively. However, these two processes generate environmental pollutants, such as furans, dioxins, and highly acidic wastewater.

- 4) A low temperature, high energy soldering composition for joining metals together contains a _____ and high energy metal particles that possess sufficiently high internal energy, suspended in the _____, such that the melting point of the high energy metal particles is depressed by at least three degrees Celsius below the normal bulk melting temperature of the metal.
- 5) Liquid _____, also called cyaniding, is carried out in a molten salt bath, using a mixture of cyanides XCN, XCNO, and X₂CO₂ (X: Na or K). The hardening agents CO and elemental N are produced in the bath in the presence of air. It is possible, within limits, to regulate the relative amounts of carbon and nitrogen in the surface layer. The treatment time ranges from 15 minutes to 3 hours. This process gives a hard layer in alloys such as stainless steel, for which gas _____ cannot give sufficient hardness.
- 6) Designing _____ systems involves understanding the primary function of the lining. It is very important to understand the process and how the _____ system functions relative to the process. Elements of refractory design include lining thickness, choice of refractory, heat transfer, choice of anchoring.
- 7) Cement production involves the heating, calcining and _____ of an accurate mix of calcareous and argillaceous materials, usually limestone and clay. _____ is a thermal treatment for bonding particles into a coherent, predominantly solid structure via mass transport events that often occur on the atomic scale.
- 8) _____ elements that are soluble in the refractory metal can greatly improve properties through solution strengthening. A particularly interesting example is _____ of Re to Cr, Mo or W. Rhenium increases the interstitial solubility, which reduces impurity segregation to dislocations and grain boundaries, resulting in improved low-temperature ductility and increased high-temperature strength.
- 9) In the temperature range around 200°C, eutectic mixtures of alkali hydroxides were selected as candidate materials. In this selection, the heats of _____ of the mixtures were calculated by assuming additivity of the entropies of _____ of the components, because the heats of _____ of eutectic mixtures are generally not available but only the eutectic temperatures.
- 10) _____ is a complex function of tear strength, coefficient of friction, resilience, heat dissipation, and other properties, and comparative values depend on the type of test. In general, COPEs are superior in _____ to many flexible materials including polyvinyl chloride and some rigid plastics. If high mechanical strength is required in an abrasive environment, COPE elastomers will outperform polyurethanes and rubber. If scuff resistance is important, polyurethanes and rubber will often give better resistance than COPEs.
- 11) Every metal which is electronegative in relation to the extracted metal may be used for _____. For example, zinc is used to precipitate silver or gold from cyanide

or bromide solutions and the excess zinc is removed by oxidation in remelting noble metals which do not oxidize. _____ is not selective and almost all other metallic elements present in the solution are cemented also by zinc. This behavior may be used for the purification of solutions of strongly electronegative elements. For example, the addition of finely ground Zn into the ZnSO₄ solution results in _____ precipitation of impurities of the type Co, Cd, Cu, Ni, Sb, and Th, and a pure solution is obtained from which zinc is extracted by a different method.

- 12) _____ has weak saturation magnetization and very high coercivity. It dehydrates to hematite at about 300°C. _____ is an important product in low-temperature oxidation, particularly of iron sulfides, and is a constituent of manganese nodules and of the Pacific red clay facies, where it may precipitate directly from seawater.
- 13) The internal pressure of the blow air results in a considerable force against the closing mechanism of the blow _____. Blow _____ have guide pins and bushings as well as taper locks in the base insert that keep the _____ in position during the blow process.
- 14) _____ involves the pouring of molten metal into a cavity-shaped sand mold where it solidifies. The mold is made of sand particles held together with an inorganic binding agent. After the metal has cooled to room temperature, the sand mold is broken open to remove the casting. The main advantage of _____ is the low cost of the mold, which is a large expense with permanent mold casting methods. The process is suitable for low-volume production of castings with intricate shapes, although it does not permit close tolerances and the mechanical properties of the casting are relatively low owing to the coarse grain structure as a result of the slow cooling rate.
- 15) A steady flow of blast requires periodic clearing (or ‘punching’) of the _____ to remove matte accretions that build up at their tips. Punching is done by ramming a steel bar completely through the _____ holes. It is usually done with a Gaspe mobile carriage puncher that runs on rails behind the converter. The puncher is sometimes automatically positioned and operated. The input rate of blast per _____ is about 12 Nm³/min at 1.2 bar. This gives _____ tip velocities of 80–120 m/s. Blowing rates above 17 Nm³/min per _____ cause slopping of matte and slag from the converter. High blowing rates without slopping are favored by deep submergence of the _____ in the matte.
- 16) Recrystallization is a microstructural transformation, which is most directly measured by quantitative optical _____. Electron backscatter diffraction (EBSD) has become a useful tool because one can use orientation spread to partition automatically the maps between recrystallized and unrecrystallized regions. However, it is

also possible to follow the progress of recrystallization by the measurement of various physical or mechanical properties, such as indentation hardness, electrical resistance, or heat released during calorimetry.

- 17) _____ (and master alloys in general) have been developed to improve the properties of steels and alloys by introducing specific alloying elements in desirable quantities in the most feasible technical and economic way. _____ are namely alloys of one or more alloying elements with iron, employed to add chemical elements into molten metal. Not a single steel grade is produced without _____

7. Translate the sentences into English. The words in bold should be taken from the unit's list of terms.

- 1) Сталь, прошедшая процесс **эко-травления поверхности**, приобретает высокую степень стойкости к последующему развитию поверхностного оксида (ржавчины), если она не вступает в непосредственный контакт с влагой.
- 2) Эффективный адсорбент также должен обладать улучшенными механическими свойствами, приводящими к **стойкости к истиранию** и хорошим кинетическим свойствам, чтобы он мог легко адсорбировать молекулы адсорбата, используя свои адсорбционные участки.
- 3) Металлические фракции очищаются и извлекаются на стадии предварительной обработки с использованием **гидрометаллургических, пирометаллургических**, электрометаллургических и биометаллургических процессов, иногда с использованием комбинации процессов.
- 4) Равновесная структура сплава может быть определена экспериментально с помощью **металлографии** и термического анализа.
- 5) **Дифракция нейтронов** - это очень мощный метод исследования структуры конденсированного вещества.
- 6) Скорость **прокаливания** является функцией баланса термодинамических и кинетических процессов.
- 7) Применение **передовой высокопрочной стали** в автомобилестроении позволяет снизить вес кузова белого цвета при одновременном выполнении высоких требований заказчиков, регуляторов безопасности и автомобильной промышленности в отношении безопасности, особенно в условиях аварии.
- 8) **Аустенитный ковкий чугун** почти в два раза прочнее обычных марок ковкого чугуна ASTM, сохраняя при этом высокие характеристики удлинения и ударной вязкости.
- 9) Аэрогели были вторично восстановлены путем термического **отжига** с последующим естественным охлаждением до комнатной температуры.

- 10) Было показано, что бораты кальция являются полезными **флюсующими агентами** в производстве цемента, поскольку они снижают вязкость и поверхностное натяжение расплава.
- 11) В промышленности используется **песочное литье** для производства магнелиевых сплавов и некоторых видов деталей из алюминиевых сплавов сложной формы.
- 12) Пиритный **огарок** является побочным продуктом производства серной кислоты, которая состоит в основном из гематита и кремнезема.
- 13) **Фурмы** Пирса-Смита представляют собой трубы из углеродистой стали или **нержавеющей стали**, встроенные в огнеупорный материал конвертера.
- 14) Производство **ферросплавов** является важной частью производственной цепочки между добычей полезных ископаемых и металлургией стали и сплавов: основной задачей **ферросплавной** промышленности является первичное извлечение (восстановление) необходимых металлов из природных минералов.
- 15) Измерение энтальпий и энтропий **плавления** дало интересную информацию об относительной важности различных факторов, влияющих на температуру плавления конкретных полимеров.

8. Put the parts in order to form a sentence.

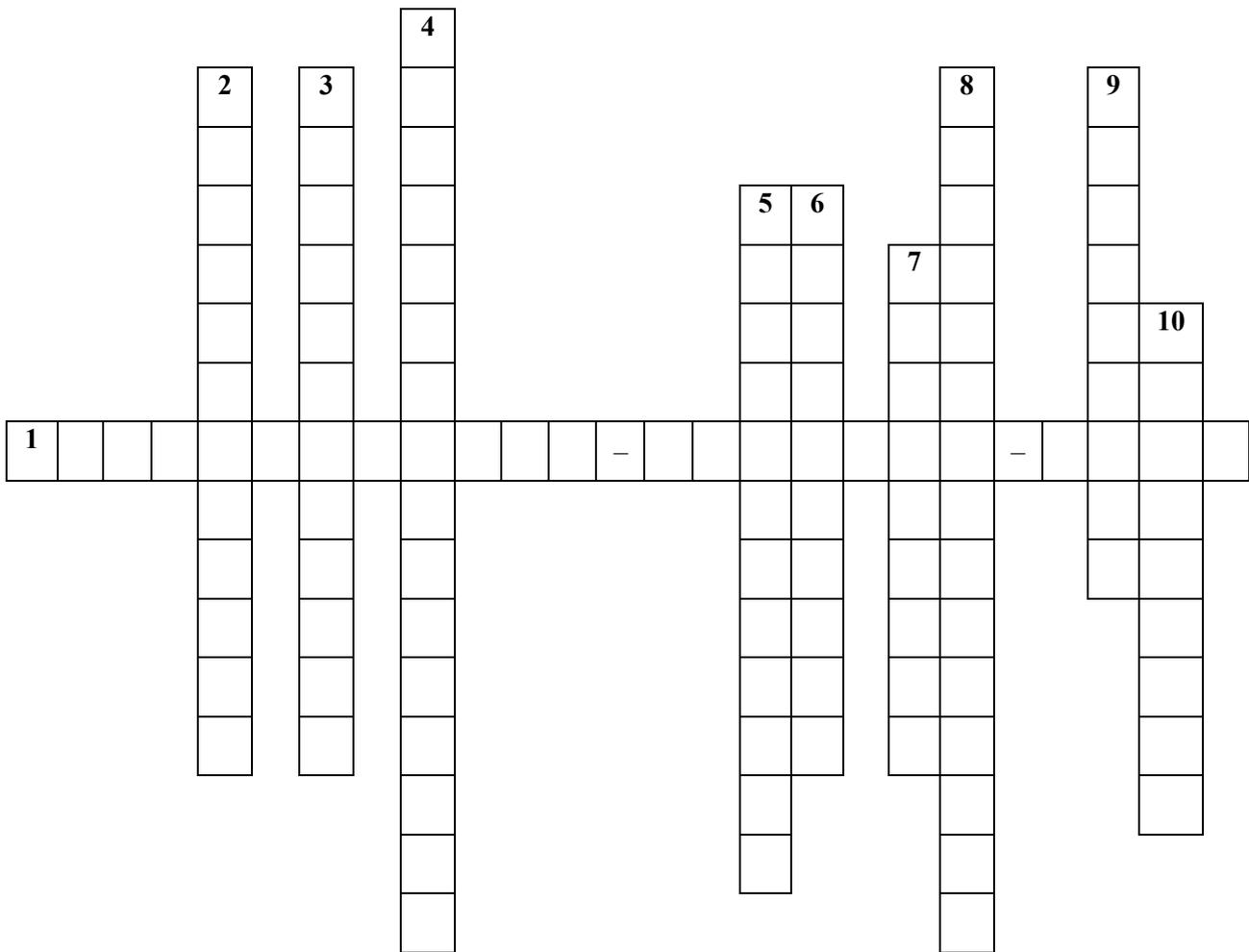
- 1) or/ the general/ used to/ powders/ class of/ thermal/ synthesize/ ceramic/ refers to/ or shaping/ before/ thermolysis/ dispersion/ or prepare/ calcination/ processes/
- 2) glasses/ tool/ is also/ of the structure/ neutron/ such as/ a very/ of noncrystalline/ and/ for the study/ important/ forms/ liquids/ diffraction/ of matter,/
- 3) process/ sound/ obtain/ a low-pressure/ sand casting/ is/ the Cosworth/ process/ used to/ castings/
- 4) a new/ pickling,/ low/ environmentally/ with/ the product/ Eco Pickled Surface/ a rust/ alternative/ to acid/ providing/ and/ is/ cost/ inhibitive/ surface/ friendly/
- 5) of/ steel/ under/ and the automotive/ demands of/ crash/ enables/ high-strength/ while/ of the weight/ fulfilling/ the high/ advanced/ regarding/ the reduction/ in auto body/ customers,/ safety/ the application/ engineering/ of the body-in-white/ regulators,/ especially/ industry/ safety,/ conditions/
- 6) from/ as a fuel/ oven/ furnace/ and/ blast/ furnace/ in a pollution/ heating/ control/ a high/ consisting of/ a dry/ wet/ to distribution/ the blast/ in boilers,/ are cleaned/ stoves/ system/ and coke/ flue/ the gases/ venturi scrubber prior/ energy/ dust catcher/
- 7) 10 to 30 percent/ usually/ alloy/ of a group of/ chromium/stainless steel,/ any one/ steels/ containing/

- 8) the higher/ was achieved/ in paste/ waste/ specimens/ abrasion resistance/ for mine/ binders/
- 9) and stiffer/ films/ causes/ portion/ in the crystalline/ thermal/ layer/ an increase/ annealing/ of the parylene/ because of/ more brittle/
- 10) properties/ offering/ engineers/ ductile iron/ the design/ a group of/ ductile irons/ mechanical/ austempered/ is/ remarkable/
- 11) metal/ migrates/ and chromium/ during/ the carbon/ boundary/ the base/ stress/ relieving/ forms/ towards/ from/ carbides/ the fusion/
- 12) aqueous/ recycled/residual/ extractive/ the use of/ concentrates,/ the hydrometallurgy/ and/ chemistry/ for/ metals/ the recovery of/ technique/ materials/ from/ ores,/ involves/
- 13) elements/ the alloying/ are soluble/ that/ metal/ alloyage/ in the base/ the principle/ is based on/

9. Solve a crossword puzzle using the terms of this unit.

- 1) Spheroidal graphite (SG) iron with added alloying elements, (usually Mo, Ni, and/or Cu) sufficient for a bainitic structure, usually with retained austenite, to be produced in the section size by austempering.
- 2) The process of extracting the metals from a solution based on the electrochemical reaction between the cementing metal and the ion of the precipitated metal.
- 3) Coarse accumulations of large blocks of volcanic material that contain at least 75% bombs.
- 4) A chemical metallurgy method that conducts separation and extraction of metals based on the reaction in an aqueous medium.
- 5) Heat treating a powder to fuse it and enlarge its primary crystallite size, which is good for refractories or plasma spraying, but not for sintering into a ceramic.
- 6) A process in which the particles of a powder are welded together by pressure and heating to a temperature below its melting point.
- 7) A dynamic process consisting of mechanical, heat, and mass transfer, and chemical phenomena with phase transformations and complex multiphase interactions between solid, liquid, and gaseous phases.
- 8) The science and technology of extracting or refining nonferrous metals from metallurgical materials at elevated temperatures.
- 9) A secondary mineral that forms from the oxidation of galena ores. It forms as coatings and encrustations with the internal tetragonal crystal structure. It is dimorphous with the orthorhombic form massicot.

10) A widespread soil mineral and a major component of many ores, sediments, and soils and it is one of the most thermodynamically stable iron oxide.



10. Reading and discussion.

a) Read the text and some applications of the new technology developed at Iowa State University.

Metal ... : Finding a better way to recover precious metals from electronic waste

Source link: <https://www.sciencedaily.com/releases/2021/03/210301133633.htm>

Date: March 1, 2021

Source: Iowa State University

Inspired by nature's work to build spiky structures in caves, engineers at Iowa State University have developed technology capable of recovering pure and precious metals from the alloys in our old phones and other electrical waste.

Using controlled applications of oxygen and relatively low temperatures, the engineers say they can dealloy a metal by slowly moving the most reactive components to the surface where they form stalagmite-like spikes of metal oxides.

That leaves the least-reactive components in a purified, liquid core surrounded by brittle metal-oxide spikes "to create a so-called 'ship-in-a-bottle structure,'" said Martin Thuo, the leader of the research project and an associate professor of materials science and engineering at Iowa State University.

"The structure formed when the metal is molten is analogous to filled cave structures such as stalactites or stalagmites," Thuo said. "But instead of water, we are using oxidation to create these structures."

Thuo noted this project is the exact opposite of his research group's previous work to develop heat-free solder. "With heat-free solder, we wanted to put things together," he said. "With this, we want to make things fall apart." But not just fall apart any which way. Thuo and the engineers in his research group want to control exactly how and where alloy components fall apart, or dealloy. They offered a more precise description in their paper: "This work demonstrates the controlled behavior of surface oxidation in metals and its potential in the design of new particle structures or purification/dealloying. By tuning oxidation via temperature, oxidant partial pressure, time and composition, a balance between reactivity and thermal deformation enables unprecedented morphologies."

Those unprecedented forms and structures could be very useful to recover precious metals from e-waste or mixed metal materials. The researchers proved that the traditional electrochemical or high-temperature methods (above 1,832°F) may not be necessary for metal purification as the metal's reactivity can be used to drive separation. The oxidation technology works well at temperatures of 500-700°F.

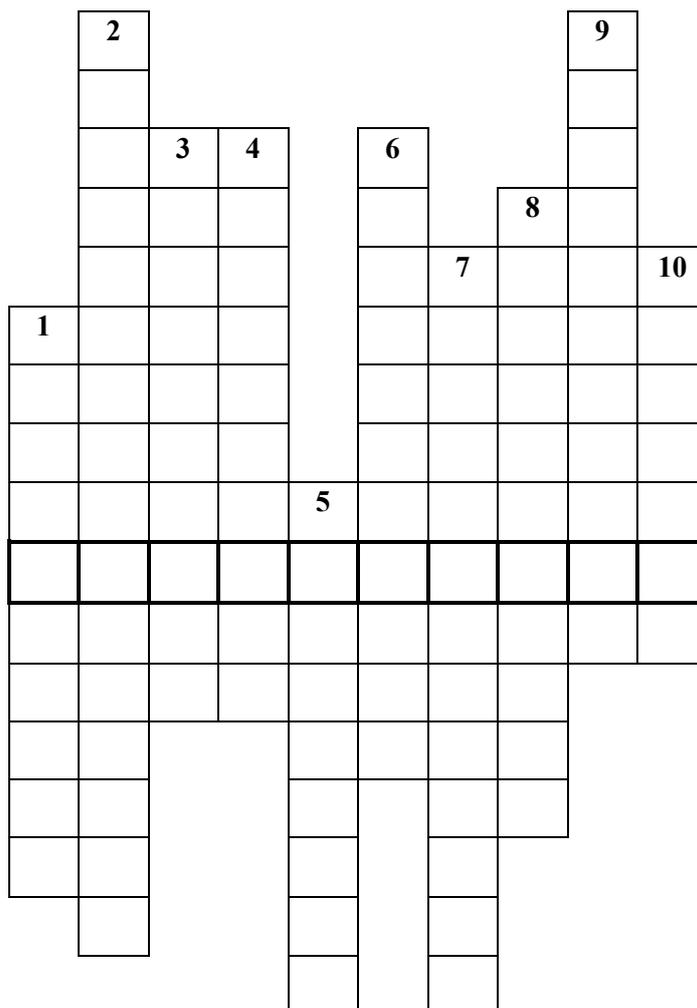
Besides metal purification and recovery, this new idea could also be applied to metal speciation -- the ability to dictate the creation and distribution of certain metal components. One use could be the production of complex catalysts to drive multi-stage reactions.

b) Circle the word or phrase to make true statements.

- 1) Using controlled applications of *nitrogen/oxygen* and relatively low temperatures, the engineers can dealloy a metal by slowly moving the most reactive components to the surface.
- 2) The structure formed when the metal is *molten/crystalized* is analogous to filled cave structures such as stalactites or stalagmites.

- 3) M. Thuo noted this project is the exact *opposite/similarity* of his research group's previous work to develop heat-free solder.
- 4) Those unprecedented forms and structures could be very *difficult/useful*.
- 5) M. Thuo said the oxidation technology works well at temperatures of *500 to 700/of 800 to 1200* degrees Fahrenheit.

c) **Crossword.** Complete the sentences from the text and you can see the word that is missing in the title of the article.



- 1) "We built on this big idea very slowly," he said. "And working together, we were able to break into this ... gap."
- 2) What we demonstrate here is that the traditional ... or high-temperature methods may not be necessary for metal purification as the metal's reactivity can be used to drive separation.
- 3) "But instead of water, we are using ... to create these structures."
- 4) One use could be the production of complex ... to drive multi-stage reactions.

- 5) We need new methods to recover ... metals from e-waste or mixed metal materials.
- 6) Thuo and the engineers in his research group want to control exactly how and where alloy ... fall apart, or dealloy.
- 7) Besides metal purification and recovery, this new idea could also be applied to metal speciation -- the ability to dictate the creation and ... of certain metal components.
- 8) By tuning oxidation via temperature, oxidant partial pressure, time, and composition, a balance between ... and thermal deformation enables unprecedented morphologies.
- 9) A paper describing the new technology, "Passivation-driven speciation, ... and purification."
- 10) This work demonstrates the controlled behavior of surface oxidation in metals and its potential in ... of new particle structures or purification/dealloying.

d) Visit one of the websites <https://academic.oup.com/>, <http://abc-chemistry.org/>, <http://www-jmg.ch.cam.ac.uk/data/c2k/cj/> or any other website publishing research articles in Chemistry, choose an article, read and summarize its content using the plan and useful phrases in the Appendix. The length of the summary should be about 10 % of the original text.

Unit 8. Chemical Technology, Industrial Chemistry, and Petrochemistry

1. Read the text and think why these three sectors were unified into one or why it wasn't worth it. What are the boundaries of the chemical industry?

Nowadays, chemistry and **chemical technology** are some of the main bases of development in modern life. However, development should continue in a way that is useful and safe for mankind. The idea known as sustainable development is fulfilling present needs without compromising the needs of future generations. Therefore, it is important that all professionals in the field of chemistry work on sustainable development.

Examples of sustainable development practices in the industrial sector are:

1. Production and marketing of products that are environmentally safe and harmless to the health of any organisms;
2. The use of green technologies to avoid producing toxic waste;
3. The reuse of natural resources;
4. Renewable energy usage.

Chemical technology builds a bridge between natural sciences and classical engineering in a modern, forward-looking, and fascinating way. It can be applied in a wide range of fields in many industries and contributes to almost three-quarters of total world economic output.

Although the **chemical industry** may be described simply as the industry that uses chemistry and manufactures chemicals, this definition leaves open the question of what a chemical is.

Petrochemistry is the branch of chemistry concerned with crude oil and fossil fuels. Examples of petrochemicals include ammonia, acetylene, benzene, and polystyrene. Petrochemistry covers the area of producing such materials as plastics, explosives, fertilizers, and artificial fibers.

The scope of the chemical industry is in part shaped by custom rather than by logic. The petroleum industry is usually thought of as separate from the chemical industry, for in the early days of the petroleum industry in the 19th-century crude oil was merely subjected to a simple distillation treatment. Modern petroleum industrial processes, however, bring about chemical changes, and some of the products of a modern refinery complex are chemicals by any definition. The term *petrochemical* is used to describe these chemical operations, but, because they are often carried out at the same

plant as the primary distillation, the distinction between the petroleum industry and the chemical industry is difficult to maintain.

Metals in a sense are chemicals because they are produced by chemical means, the ores sometimes requiring chemical methods of dressing before refining; the refining process also involves chemical reactions. Yet the steel industry, for example, is not considered a part of the chemical industry.

The boundaries of the chemical industry are somewhat confused. Its main raw materials are fossil fuels, air, water, salt, limestone, sulfur, or an equivalent, and some specialized raw materials for special products, such as phosphates and the mineral fluor spar. The chemical industry converts these raw materials into primary, secondary, and tertiary products, a distinction based on the remoteness of the product from the consumer, the primary being the most remoted. The products are most often end products only as regards the chemical industry itself; a chief characteristic of the chemical industry is that its products nearly always require further processing before reaching the ultimate consumer.

There are many routes to the same product and many uses for the same product. The largest use for ethylene glycol, for example, is as automobile antifreeze, but it is also used as hydraulic brake fluid. Further processing leads to many derivatives that are used as additives in the textile, pharmaceutical, and cosmetic industries; as emulsifiers in the application of insecticides and fungicides; and as demulsifiers for petroleum. The fundamental chemicals, such as chlorine or sulfuric acid, are used in so many ways as to defy a comprehensive listing.

Source links: <https://www.sciencedirect.com/topics/engineering/chemical-technology>
<https://www.britannica.com/technology/chemical-industry>

2. Match the terms (1-13), transcriptions (a-m), and translations (i-xiii).

1. coking	a) [ˈdɪstrɪˈleɪʃ(ə)n]	i. высушивание
2. condenser	b) [ˈniːəv,prɪːn]	ii. депарафинизация
3. cracking	c) [rɪˈfɔːmɪŋ]	iii. тринитроглицерин
4. cumene	d) [kənˈdensə]	iv. нитрирование, азотизация
5. dewaxing	e) [ˌnaɪtrəvˈglɪsəriːn]	v. дистилляция
6. distillation	f) [ˈnaɪtraɪdɪŋ]	vi. конденсатор
7. drying	g) [ˈkjuːmiːn]	vii. пиролиз (дегазация)
8. neoprene	h) [ˈkəʊkɪŋ]	viii. кумол
9. nitriding	i) [paɪˈrɒlɪsɪs]	ix. риформинг
10. nitroglycerine	j) [ˈkrækɪŋ]	x. коксование

11.polyurethane	k) [ˈpɒliˈju(ə)rəθeɪn]	xi. полиуретан
12.pyrolysis	l) [ˈdraɪlɪŋ]	xii. крекинг
13.reforming	m) [diːˈwæksɪŋ]	xiii. неопрен

3. For each definition (a-m) choose a suitable term from task 2 (1-13).

- a) The process of partially or removing water or other liquids from a solid.
- b) The thermal degradation of an organic substance in the absence of air to produce char, pyrolysis oil, and synthesis gas, e.g., the conversion of wood to charcoal.
- c) A well-defined separation unit consisting of the partial evaporation of a liquid mixture and successive condensation, with a composition that differs from that of evaporation.
- d) The manufacture of coke via the destructive distillation of coal / the heating of coal in the absence of air (oxygen) to a temperature above 600 °C, to drive off the volatile components of the raw coal, leaving a hard, strong, porous material of high carbon content, called "coke".
- e) A catalytic process, whereby short-chain molecules are combined to make larger ones; used in the petrochemical industry.
- f) A class of resins, flexible to rigid depending on the chemical structures of the polyisocyanates and polyols. A class of block copolymers synthesized from three different reagents: a polyol, a di- or multi-isocyanate, and a chain extender.
- g) A thermochemical surface treatment process generally used for treating ferrous/austenitic alloys by introducing atomic nitrogen into the ferrite phase at a wide range of temperatures (340–590 °C).
- h) The aromatic hydrocarbon isopropyl benzene present in petroleum.
- i) Process removing wax (normal kinds of paraffin) from lube base stocks either with a catalytic system or by separation with a solvent.
- j) A family of synthetic rubbers that are produced by polymerization of chloroprene, that is resistant to oils and aging.
- k) A catalytic process of oil refinery for decomposition large hydrocarbon molecules into smaller molecules.
- l) The compound glyceryl-tri-nitrate or 1,2,3 tri-nitrooxy propane; the ester of glycerol with nitric acid; prepared by the careful addition of a mixture of nitric and sulphuric acids to glycerol with constant stirring and cooling; it is a thick, pale yellow liquid, highly explosive on concussion or exposure to sudden heat.
- m) A device or unit in systems involving heat transfer used to condense a gaseous substance into a liquid state through cooling.

4. Complete the paragraphs using the terms studied in this unit (task 2). In some sentences the plural form is required. In each paragraph, the same word is missing.

- 1) _____ includes combustion, the production of carbon products, and conversion to liquid and gaseous fuels. The effects of cations on _____ at rapid heating rates have been investigated using the fluidized bed and shock tube techniques. The investigations show that considerable progress has been made in understanding the details of the _____ of brown coals and the factors that influence the thermal decomposition process and the nature of the residual chars and volatile products.
- 2) A _____ is a two-phase heat exchanger since the refrigerant-side design anticipates a change of phase from gas to liquid between entering and leaving conditions. _____ are used in a variety of operations in chemical and petroleum processing, including distillation, refrigeration, and power generation. Virtually, every distillation column employs either a partial or total _____ to liquefy some, or all, of the overhead vapor stream, thereby providing reflux for the column and (often) a liquid product stream. In refrigeration operations, _____ are used to liquefy the high-pressure refrigerant vapor leaving the compressor. Heat exchangers referred to as surface _____ are used to condense the exhaust from steam turbines that generate in-house power for plant operations.
- 3) Plasma _____ allows the efficient _____ of stainless steels at low temperatures with the aim of a hardened case while maintaining corrosion resistance by creating so-called expanded austenite or expanded martensite. The parts do not need to be quenched to achieve the resulting hardness. The temperature has to be maintained below the temperature at which chromium nitrides will form during the processing. The supporting plasma is causing a constant activation of the otherwise passivated surface during _____. The activation can be enhanced by sputtering before _____.
- 4) Catalytic _____ uses catalytic reactions to process primarily low octane, heavy, straight-run gasoline, and naphthas into high octane aromatics (including benzene). Four major types of reactions occur during _____ processes: 1. Dehydrogenation of naphthenes to aromatics. 2. Dehydrocyclization of paraffins to aromatics. 3. Isomerization. 4. Hydrocracking.
- 5) Conventional _____ involved the removal of aromatics by extraction using solvents such as furfural, phenols, etc. prior to the removal of n-paraffins. In a concentrated form, aromatics were separated from the solvent by distillation. During catalytic _____, n-paraffins are converted to i-paraffins. The main reactions occurring during _____ include hydrocracking and hydroisomerization. The relative contribution of these reactions to the overall _____ depends on the catalyst structure, temperature, and the origin of the feed.

- 6) The _____ method can affect the nutritional content of the finished product, although product deterioration is usually due to the application of excess heat, rather than moisture removal. _____ types can be classified by either the mechanism of heating or the mechanism of vapor transport. Air _____ requires a high-temperature air which supplies the heat and removes the water vapor, whereas vacuum _____ uses a reduction in pressure to remove the vapor.
- 7) _____ is a source of particulates, volatile organic compounds, and polynuclear aromatic hydrocarbons: uncontrolled emissions per tonne of coke are up to 7kg of particulate matter, up to 6kg of sulfur oxides, around 1kg of nitrogen oxides, and 3kg of volatile organics. _____ processes are more thermally severe than visbreaking, using temperatures in the range of 450–500°C. Thus the light boiling products would exit overhead and leave the solid coke behind. _____ in the absence of H₂ moves a high amount of heteroatoms (and CCR) into the formed coke, making it a low-value by-product.
- 8) This is the principal disadvantage of _____: its high energy usage. However, _____ has three advantages over alternative methods for the separation of homogeneous fluid mixtures: 1. The ability to handle a wide range of feed flow rates. Many of the alternative processes for the separation of fluid mixtures can only handle low flow rates, whereas _____ can be designed for the separation of extremely high or extremely low flow rates. 2. The ability to separate feeds with a wide range of feed concentrations. Many of the alternatives to _____ can only separate feeds that are already relatively pure. 3. The ability to produce high product purity. Many of the alternatives to _____ only carry out a partial separation and cannot produce pure products.
- 9) _____ exhibits good chemical stability and maintains flexibility over a wide temperature range. It is used in a wide variety of applications, such as laptop sleeves, orthopedic braces, electrical insulation, liquid and sheet applied elastomeric membranes or flashings, and automotive fan belts. The development of _____ and the Thiokol families of elastomers preceded the development and acceptance of Staudinger's concept of the macromolecule. Only after the general acceptance of the chainlike character of elastomeric materials did the scientific community begin to look for ways to exert control over the previously unpredictable behavior of the processes leading to the formation of elastomers.
- 10) _____ are widely used in medical devices such as pacemakers, artificial hearts, and other blood-contacting applications. Their excellent mechanical properties, stability, and good biocompatibility give them a special place in medicine. _____ were developed in the 1930s.
- 11) The nitration process is a general class of chemical process for the introduction of a nitro group (NO₂) into an organic chemical compound. The term is also applied

(somewhat incorrectly) to the different process of forming nitrate esters between alcohol derivatives and nitric acid, as occurs in the synthesis of _____. The difference between the resulting structure of nitro compounds and nitrates is that the nitrogen atom in nitro compounds is directly bonded to a nonoxygen atom, typically carbon or another nitrogen atom, whereas in nitrate esters, also called organic nitrates, the nitrogen is bonded to an oxygen atom that in turn usually is bonded to a carbon atom.

- 12) _____ is the common name for isopropylbenzene, an organic compound that is based on an aromatic hydrocarbon with an aliphatic substitution. It is a constituent of crude oil and refined fuels. It is a flammable colorless liquid that has a boiling point of 152 °C. Nearly all the _____ that is produced as a pure compound on an industrial scale is converted to _____ hydroperoxide, which is an intermediate in the synthesis of other industrially important chemicals, primarily phenol and acetone.
- 13) _____ is a destructive distillation process with a chemical reaction where compounds with long hydrocarbon chains are split, “cracked”, catalytically into smaller (and more volatile) compounds. _____ is a reducing process done in the oxygen-free atmosphere with high temperature and pressure with a catalyst. Catalytic _____ in the usual commercial process involves contacting the feedstock with a catalyst under suitable conditions of temperature, pressure, and residence time. By this means, a substantial part (>50%) of the feedstock is converted into gasoline and lower boiling products, usually in a single pass.

5. Make up compound terms, which consist of two or more words. Then match word combinations to their translations (a-q).

1) absorption	1. industry	a) биодизельное топливо
2) ammonia	2. disposal area	b) концентрационный предел взрываемости/ допустимая взрывобезопасная концентрация
3) Andrussow	3. distillation	c) ректификация/ фракционная перегонка
4) bauxite residue	4. converter	d) дизельное топливо
5) biodiesel	5. fertilizer	e) абсорбционная колонна/ поглотительная башня
6) chemical	6. tower	f) углехимия
7) coal chemical	7. limit	g) способ Рашига
8) combustion	8. fuel	h) процесс Андрусова

9) diesel	9. rubber	i) нефтехимический синтез
10) explosive	10. hydrolysis	j) синтетический каучук
11) fractional	11. fuel	к) зона утилизации бокситных отходов
12) mineral	12. process	l) реакционный аппарат
13) petrochemical	13. reactor	м) паровой гидролиз
14) Raschig	14. chamber	н) колонна для синтеза аммиака
15) raw	15. process	о) минеральное удобрение
16) steam	16. process	р) камера внутреннего сгорания
17) synthetic	17. materials	q) сырье, исходный материал

6. For each definition (1-17) choose a suitable compound term (consisting of two or more words) from task 5.

- 1) The limiting concentration (in the air) needed for the gas to ignite and explode.
- 2) A crude, unprocessed, or partially processed material used as feedstock for a processing operation.
- 3) A fuel derived from petroleum (or other oils) but heavier than gasoline/petrol. Used to power diesel engines which burn this fuel using the heat produced when air is compressed.
- 4) An industrial process for the production of hydrogen cyanide from methane and ammonia in the presence of oxygen and a platinum catalyst.
- 5) A long vertical column used in oil refineries and natural gas processing stations to absorb impurities from gas streams.
- 6) The fuel for diesel engines made of renewable organic raw materials as opposed to fossil hydrocarbons.
- 7) The separation of a mixture into its parts, or fractions, such as in separating chemical compounds by their boiling point.
- 8) Deriving organic intermediate products such as refinery products, natural gas, plastic, rubber, fiber raw materials from petroleum.
- 9) A chemical process for the production of hydrazine.
- 10) The interaction of a substance with water with decomposition in which the substance is not in solution.
- 11) A vertical four catalytic bed reactor with varying volumes of catalysts used to produce ammonia from nitrogen and hydrogen.
- 12) A process vessel used to carry out a chemical reaction, which is one of the classic unit operations in chemical process analysis.
- 13) A component or area of a gas turbine, ramjet, or pulsejet engine where combustion of combustible mixture or solid fuel takes place.

- 14) A diverse group of products that typically contain nitrogen, phosphorus, potassium, and other trace minerals in various chemical forms.
- 15) Any type of artificial elastomer mainly synthesized from petroleum byproducts. An elastomer is a material with the mechanical property that it can undergo much more elastic deformation under stress than most materials and still return to its previous size without permanent deformation.
- 16) An area of the chemical industry for the transformation of coal into gas, liquid, solid fuel, a wide range of chemicals through thermal or chemical processing.
- 17) A zone for utilizing a waste product from the refining of bauxite ore to alumina.

7. Complete the following paragraphs using the terms studied in this unit (task 5). In some sentences the plural form is required. In each paragraph, the same compound term is missing.

- 1) _____ is a means of physically separating petroleum into fractions based on differences in boiling point ranges. _____ is one of the most important parts of the refinery process.
- 2) Steady-state one-dimensional pseudo-homogeneous models of an axial flow industrial catalytic packed bed _____ have been developed. The converter is a vertical four catalytic bed reactor with varying volumes of catalysts. Effects of temperature changes on the catalyst surface and in its interior were incorporated in the model by an effectiveness factor. The models were used to predict conversions, concentrations of reactant/product mixtures, and temperature profiles along the catalyst beds.
- 3) Very few pieces of _____ machinery lend themselves to early symptom-cause identification as do reciprocating compressors. This becomes evident when considering how the neglect of subtle performance changes can result in costly wrecks. For instance, high discharge temperatures can result from the simple primary cause of insufficient cooling water.
- 4) The _____ is also called the contact tower. This tower when it has a small diameter can use a packed tower style, and with a large diameter should adopt the bubble column of the column tray type. The bubble column of the column tray type is commonly used on a sea platform, and usually the column trays number about 4 ~ 6, with plate spacing about 0.6 m.
- 5) The _____ can be divided into traditional coal chemical and new _____. The former mainly includes the production of synthetic ammonia, coke, calcium carbide, and other sub-sectors, while the new _____ produces petroleum substitutes, including ethylene glycol, oil, olefins, etc.
- 6) _____ oil is essentially the same as furnace fuel oil, but the proportion of cracked gas oil is usually less since the high aromatic content of the cracked gas oil reduces

the cetane value of the _____. The allowable sulfur content for ultra-low sulfur kerosene and ultra-low sulfur _____ (15 ppm) is much lower than the previous US on-highway standard for low sulfur _____ (500 ppm), which not only reduces emissions of sulfur compounds (a cause of acid rain) but also allows advanced emission control systems to be fitted that would otherwise be poisoned by these compounds. These systems can greatly reduce emissions of oxides of nitrogen and particulate matter.

- 7) _____ are the most popular source of nutrients, albeit the low application rates and high marginal rate of returns. _____ have increased the ion concentration in the soil liquid phase, and changes in the content and the ratio of all components of soil solutions take place, resulting from the interaction with SAC. Our laboratory experiments simulating the addition of _____ have shown that the increase in K activity is disproportional to the added amount and constitutes only 2-20% of the respective increase in NO_3 activity.
- 8) The _____ for the production of natural dyes is mostly vegetable matter such as seeds, leaves, roots, bark, heartwood, etc., of the plants. The most important part of the production of natural dyes is the sourcing of the _____. The _____ selected for the extraction of the coloring matter should be easily available at a reasonable price and in large quantity throughout the year. For the procurement of the _____, proper specifications in terms of moisture content, ash content, water or alkali, extractable matter, and the absorption spectra must be specified to ensure reproducible results.
- 9) The hydrolysis of fats or oils with water produces fatty acids and glycerol. Currently, the countercurrent, continuous, high pressure, high temperature, liquid phase Colgate-Emery process, which uses a catalyst to promote the reaction, is the state-of-the-art method of fat hydrolysis. Non-catalytic _____ is a possible alternative. Significant degrees of hydrolysis may be achieved by continuously sparging superheated steam through high-temperature fat at atmospheric pressure. A "bench-scale" hydrolyzer was designed and constructed to investigate the feasibility of _____ and was tested with soybean oil and beef tallow.
- 10) In the _____, ammonia and air are fed to a platinum gauze catalyst consisting of many layers of gauze of the 1/2-inch total thickness. The product HCN in this method is of a higher concentration than in the _____, and no wastewater is produced. A disadvantage is the large financial investment needed.
- 11) A _____ is part of an engine in which fuel is burned. The leftover hot gases produced by this combustion tend to occupy a far greater volume than the original fuel, thus creating an increase in pressure within the limited volume of the _____. This pressure can be used to do work, for example, to move a piston on a crankshaft. A _____ must be capable of allowing fuel to burn efficiently over a wide range of operating conditions without incurring a large pressure loss.

- 12) The _____ of a gas or a vapor is the limiting concentration (in the air) that is needed for the gas to ignite and explode. There are two _____ for any gas or vapor, the lower _____ (LEL) and the upper _____ (UEL). At concentrations in air below the LEL there is not enough fuel to continue an explosion; at concentrations above the UEL the fuel has displaced so much air that there is not enough oxygen to begin a reaction. Concentrations of explosive gases are often given in terms of percent of lower _____.
- 13) The _____ passes benzene, hydrogen, and air over a heated copper catalyst at 200° to 300°C. The intermediate product is chlorobenzene and water in the gaseous state. The water hydrolyses the chlorobenzene, when passed over hot silica catalyst at 500°C, to phenol and HCl.
- 14) The _____ process brought to a successful culmination during World War II required large quantities of butadiene; consequently, normal butenes, the feedstock to butadiene units, were also in great demand. ED process technology was developed to recover high purity n-butenes suitable for producing butadiene to feed the _____ process.
- 15) _____ appear to result in the heavy metal pollution of the farm fields surrounding them. In total, 194 topsoil samples were collected from the fields surrounding a _____ in Guangxi to comprehensively understand the pollutant characteristics. These characteristics and their ecological risks were assessed by the Nemerow and Harkanson indices, whilst the sources and correlations of eight heavy metals (V, Cr, Ni, Cu, Zn, As, Pb, and Co) were analyzed using the spatial interpolation method, correlation analysis, and principal component analysis.
- 16) _____ is one of the sources of renewable fuel. _____ is produced from edible oil wastes, such as goat fat, chicken fat, and palm kernel-derived oil using the transesterification process. The produced _____ is mixed with different ratios of petroleum diesel to improve the physical properties of the produced _____, such as flash point, kinematic viscosity, density, cloud point, and pour point.
- 17) _____ have always been considered as the heart of chemical processes. Improved reactor design and operation will usually translate into significant cost savings and revenue potentials for the chemical plants. Various analytical methods and design strategies have been introduced to handle the complex nature of these problems. Among such methods are attainable region, phenomena vectors, and superstructure optimization. Many trade-offs must be considered carefully when designing a _____: balancing the reactor size with reactant conversion, balancing reactant conversion with selectivity, balancing heat transfer area with hot spot temperature, etc.

8. Make words or word combinations by putting the entangled letters in the correct order.

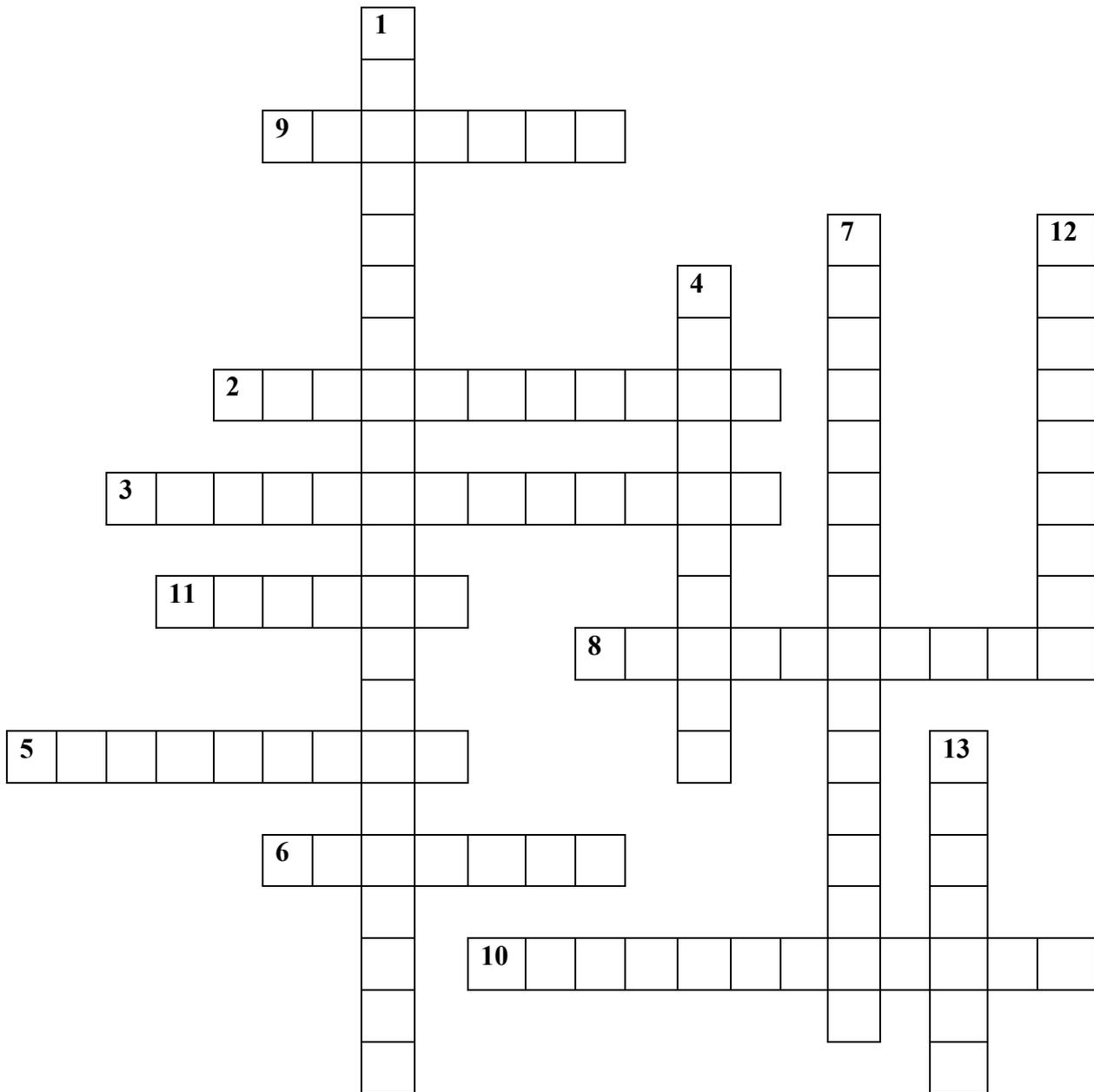
- | | | |
|----------------------|----------------------|---------------------|
| 1) rfrmtalriiilzeene | 5) hybsecerrbtiunt | 9) ittidanoilsl |
| 2) aerwlatriams | 6) lereitynoicgnr | 10) omtlsaedryisysh |
| 3) acnriaeoortmmnve | 7) crmsnemhaoctibubo | 11) pwsorotbinratoe |
| 4) siiblfueedleo | 8) eedfilusle | 12) ielloeitxmsivp |

9. Put the parts in order to form a sentence.

- 1) Revegetation/ residue/ promising/ on bauxite/ risk/ during/ the most/ stacking/ to reduce/ ecological/ its potential/ strategy/ or disposing/ disposal areas/ is/
- 2) A chemical/ from metal,/ often/ manufactured/ high/ resistant/ stainless steel/ a vessel/ reactor/ alloys/ is/ or/
- 3) There is/ in supply/ industry/ rise in/ the unbalance/ price/ a lot of/ due to/ interest in/ demand/ and/ Coal Chemical/ and/ of oil/
- 4) Delayed/ type of/ place/ coker/ in the refining/ introduced/ the first/ was/ market/ coking/
- 5) Cracking/ more useful,/ and alkene/ converts/ large/ alkane/ molecules/ molecules/ alkane/ into smaller,/
- 6) The cumene/ study/ environmental,/ process/ of economic,/ criteria/ as a case/ to perform/ optimization/ a multi-objective/ production/ and social/ sustainability/ was adopted/
- 7) Solvent/ filtration,/ recovery/ consists of/ and solvent/ dewaxing/ crystallization,/
- 8) Diesel/ straight-run/ obtained/ products/ originally/ fuels/ the distillation/ of crude/ were/ oil/ from/
- 9) Freeze/ four distinct stages:/ which has/ generation/ is/ technology,/ freezing,/ vacuum,/ drying/ drying/ sublimation/ and condensing/ a third/
- 10) Controlling/ a major/ outside/ limits/ concentrations/ and health/ the explosive/ consideration/ is/ gas and vapor/ in occupational/ safety/
- 11) Neoprene/ industrial/ and surfing/ products,/ suits/ from/ in many/ to/ wet/ for scuba/ hoses/ diving/ is used/ commercial/
- 12) Polyurethanes,/ of paints/ their high/ solvents,/ have been used/ resistance/ to weathering,/damage,/in/the manufacture/ and varnishes/ and mechanical/ due to/
- 13) Pyrolysis/ plastics/ biofuels/ renewable/ technology/ waste/ for converting/ is/ into/ a potential/
- 14) Products/ gasoline/ high-octane/ catalytic/ useful as/ aromatics,/ include/ reforming/ and hydrogen/ automobile/ from/ fuel,/

10. Solve a crossword puzzle using the terms of this unit.

- 1) A field where transforms coal into gas, liquid, solid fuel and a wide range of chemicals through thermal or chemical processing.
- 2) A heavier fraction of crude oil than kerosene, comprising a band of hydrocarbons, with an average composition of $C_{12.9}H_{23.9}$ and molecular weight of 178.6.
- 3) The most commonly used method for the separation of homogeneous fluid mixtures. Separation exploits differences in boiling point, or volatility, between the components in the mixture.
- 4) A chemical process used to convert petroleum refinery, naphtha's, typically having low octane ratings, into high-octane liquid products called reformates are components of high-octane gasoline (also known as high-octane petrol).
- 5) A process in which wax is removed from a material or a surface.
- 6) An important industrial intermediate in the manufacture of phenolic and polycarbonate resins, nylon and epoxy.
- 7) An industrial tower used to separate out components of a rising gas with the use of a falling liquid to trap the gas.
- 8) A thermochemical surface treatment process generally used for treating ferrous/austenitic alloys.
- 9) The destructive distillation of coal / the heating of coal in the absence of air (oxygen) to a temperature above 600 °C.
- 10) A crude, unprocessed or partially processed material used as feedstock for a processing operation.
- 11) For an industrial _____ hydrolysis process the fat or oil feed would initially be deaerated and then heated to reaction temperature.
- 12) A catalytic process of oil refining for decomposition large hydrocarbon molecules into smaller molecules.
- 13) The process of partially or totally removing water or other liquids from a solid.



11. Translate the sentences into Russian. The words in bold belong to the unit's list of terms.

- 1) The natural gas is passed through an absorption tower and brought into contact with the absorption oil, which soaks up a large amount of NGLs.
- 2) With over 60 years of experience in the ammonia industry, Topsoe provides flexible and highly efficient ammonia converter solutions.
- 3) Based on the on-the-spot investigation on bauxite residue disposal areas (BRDAs), the important value, as well as indices of plant species' evenness and diversity, were calculated.

- 4) The obtained results show that some of the properties of final biodiesel, such as density, viscosity, and flash point are improved with the addition of biodiesel to the diesel fuel.
- 5) Although the development of new coal chemical industries is receiving increasing attention, the constraints of new environmental laws and carbon emission reduction targets continue to increase.
- 6) Coking wastewater discharged from coking plants contains a high concentration of ammonia nitrogen and carries a lot of phenols and tars.
- 7) The combustion chamber is designed as an adiabatic furnace and is dimensioned to optimize the combustion of the specified fuel types.
- 8) Ejector condensers improve system efficiency by condensing the ejector motive steam and a portion of the saturation vapors to reduce the compression load on the flowing stages in the gas removal system.
- 9) Power recovery turbines can be installed on catalytic cracking units to produce power from the pressure of the off-gases of the catalytic cracking.
- 10) There are several processes in use for solvent dewaxing, but all have the same general steps, which are: (1) contacting the feedstock with the solvent, (2) precipitating the wax from the mixture by chilling, and (3) recovering the solvent from the wax and dewaxed oil for recycling.
- 11) The flash point of the biodiesel is higher than diesel products derived from oil. In order to decrease the flashpoint of the final composition, the biodiesel has to be blended with different ratios of diesel.
- 12) Spray drying is a second-generation drying technology, which is defined by the formation of a spray of droplets, which are produced for optimum evaporation and contact with air.
- 13) Impacts of mineral fertilizers on denitrification are complex, in part because of the abundance and diversity of denitrifiers but manures and organic fertilizers tend to increase denitrification activity relative to mineral fertilizers.
- 14) Nitriding is a surface technique to harden the surfaces of several types of cold- and hot-work steels for forming operations.
- 15) Raw materials are defined as renewable if they are replenished by natural procedures at rates comparable or more rapid than their rate of utilization.
- 16) In general, each reforming stage is characterized by one or more reforming reactor vessels, each containing a catalyst and maintained at reforming reaction conditions.

17) The steam hydrolysis of fats and oils involves the contact of superheated steam at a pressure of approximately one atmosphere with a fat or oil feed.

18) Natural and synthetic rubber and synthetic resins are soluble in organic solvents, resulting in cement, resin solutions, or lacquers.

12. Reading and discussion.

a) Read the text and say what is considered to be the fuel of the future.

New method converts ... in natural gas to methanol at room temperature

Source link: <https://www.sciencedaily.com/releases/2021/02/210219095943.htm>

Date: February 19, 2021

Source: the University of Illinois at Chicago

Researchers at the University of Illinois Chicago have discovered a way to convert the methane in natural gas into liquid methanol at room temperature. This discovery, reported in the journal *Proceedings of the National Academy of Sciences*, could provide a cleaner energy source for many of our everyday activities.

When burned, natural gas produces carbon dioxide, a powerful greenhouse gas. According to the U.S. Energy Information Administration, the U.S. consumed approximately 31 trillion cubic feet of natural gas in 2019, contributing roughly 1.6 gigatons of carbon dioxide to the atmosphere. A better way to use natural gas would be to convert it to methanol, a liquid fuel that burns more cleanly and can be used to produce gasoline and plastics. But converting the methane found in natural gas into methanol requires a lot of heat and pressure and generates carbon dioxide itself.

"Researchers have been interested in ways to convert methane to methanol at ambient temperatures to sidestep all the heat and pressure that is currently required in industrial processes to perform this conversion," said Meenesh Singh, assistant professor of chemical engineering at the UIC College of Engineering.

Methanol also is thought to be the "fuel in the future," driving a "methanol economy" where it replaces fossil fuels in transportation, energy storage, and as the dominant precursor material for synthetic chemicals and other products. Methanol is currently used in fuel cell technology that powers some city buses and other vehicles. Its lower emission potentials and higher volumetric energy density make it an attractive alternative to fossil fuels. Methane can be stored safely in regular containers, unlike natural gas, which has to be stored under pressure and which is much more expensive.

High amounts of heat and pressure are required to break the hydrocarbon bonds in methane gas, the first step in producing methanol. But Singh and UIC graduate student Aditya Prajapati have been able to reduce the temperature of the industrial process from more than 200°C to room temperature. They did it with the help of a catalyst composed of titanium and copper. The catalyst, together with a small amount of electricity, facilitates the breaking of the hydrocarbon bonds of methane and the formation of methanol. The process uses much less energy than traditional methods, and because it does not require machinery to produce high pressure and heat, it can be set up quickly and inexpensively. The process can be implemented in a space as small as a van and is portable for distributed utilization of natural gas and manufacturing methanol. The researchers expect that the process could convert a few liters of methane a day.

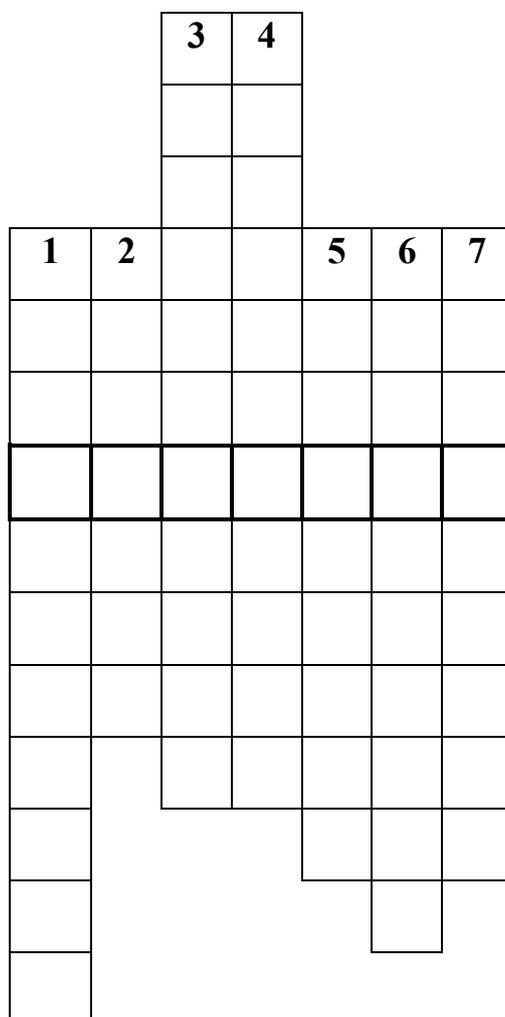
b) Read the text again and determine which of the following statements match the content of the text (True), which do not match (False), and what the text does not say (Not Stated).

- 1) Converting the methane found in natural gas into methanol requires a lot of heat and pressure and generates a significant amount of carbon dioxide itself.
- 2) Methanol is currently used in fuel cell technology that powers some city buses and other vehicles.
- 3) "Besides being a cleaner-burning fuel, methane can also be stored safely in regular containers, unlike liquid fuel, which has to be stored under pressure and which is much more expensive," Singh said.
- 4) Researchers have identified a catalyst material that helps bring down the energy needed to break these bonds so that the reaction can take place at room temperature. Their catalyst is composed of aluminum and zinc.
- 5) This methane processing process requires sophisticated equipment that requires a lot of space but allows the production of several hundred liters of methanol a day.

c) Crossword. Complete the sentences from the text and you can see the word that is missing in the title of the article.

- 1) The U.S. consumed approximately 31 trillion cubic feet of natural gas in 2019, contributing roughly 1.6 gigatons of carbon dioxide to the
- 2) This discovery could potentially provide a cleaner ... source for many of our everyday activities.
- 3) Researchers have been interested in ways to convert methane to methanol at ambient temperatures to sidestep all the heat and pressure that is currently required in ... processes to perform this conversion.
- 4) When burned, natural gas – the fuel used to heat homes, cook food and generate electricity – produces carbon dioxide, a powerful ... gas.

- 5) Methanol is a liquid fuel that burns more cleanly and can be used to produce gasoline and
- 6) Methanol replaces fossil fuels in transportation, energy storage and as the dominant precursor material for ... chemicals and other products.
- 7) High amounts of heat and ... are required to break the hydrocarbon bonds in methane gas, the first step in producing methanol.



d) Visit one of the websites <https://academic.oup.com/>, <http://abc-chemistry.org/>, <http://www-jmg.ch.cam.ac.uk/data/c2k/cj/> or any other website publishing research articles in Chemistry, choose an article, read and summarize its content using the plan and useful phrases in the Appendix. The length of the summary should be about 10 % of the original text.

Unit 9. Nanochemistry and Nanotechnology

1. Read the text about nanochemistry. Why is nanoscience considered a separate science and in what way is it connected with other fields of science?

Nanochemistry unites nanoscience and chemistry. Nanochemists work from the atom up, with the aim of engineering nanosized materials. They use several methods to prepare and assemble ‘little pieces of matter’ which display unique magnetic, electronic, optical, chemical, and mechanical behavior attributable only to their nanometer size.

It represents a novel approach to building devices atom by atom, with molecular-scale precision. It involves studying the synthesis and characterization of materials on the nanoscale, focussing on how the atoms behave and interact, and how they can be manipulated and controlled in chemical reactions at the atomic level. It centers on understanding the new rules of behavior which emerge on the nanoscale. Since all of the atoms in a nanoparticle are present on the surface, these particles exhibit chemical and physical properties that differ from the individual or aggregates of atoms or molecules. Such systems lie at the junction between classical and quantum behavior and display actions that do not exist in larger devices. Nanochemistry also focuses on how these individual atoms can assemble into larger molecules and the behavior they exhibit.

Nanochemistry is important for chemical, physical, and materials science, it has engineering, biological, and medical applications. Using single atoms as building blocks offers new ways to create innovative materials, the opportunity to create the smallest features possible in integrated circuits, and the chance to explore quantum computing for example.

It might seem relatively new, but nanochemistry has been employed for many years, for example in sunscreens that absorb UV light, in clear coatings for cars that protect the bright paint colors underneath, or in carbon nanotubes for lightweight car parts or sporting equipment. It has been used to study the health and safety effects of airborne and waterborne nanosized particulates, and nanoparticles have been used to clear up or neutralize pollutants.

Larger molecular assemblies such as dendrimers – highly branched three-dimensional nanoscale molecular objects of the same size and weight as traditional polymers – are under investigation for use in molecular recognition, nanosensing, light-harvesting, and optoelectrochemical devices. They can be synthesized in a step-by-step fashion, allowing for incredibly precise control of their size and geometry. Since they are created layer by layer, the properties of any single layer can be controlled by selecting

specific monomers, making them ideal building blocks in nanochemistry for the creation of three-dimensional structures.

Nanotubes are a relatively new form of carbon and can range from a few microns to a few nanometres with many being only a single atom thick, i.e., single-walled. They display beneficial behavior relative to properties such as electrical and thermal conductivity, strength, stiffness, and toughness. They can be functionalized – that is given a specific purpose – with the addition of molecular recognition agents which bind specifically to molecular tags, making them ideal for use as high-resolution probes in atomic force microscopy, as channels for material separation, and as selective gates for molecular sensing.

Nanocomposites constitute a wide variety of systems composed of dissimilar components mixed at the nanometer level. Their behavior is dependent on the properties of the components, their morphology, and the interactions between the individual components, which are often novel properties not seen in the parent material.

Nanocrystals and clusters are other promising areas of research. Crystals of nano-sized proportions can be combined into clusters and show potential in high-density data storage and optoelectrical applications. They might also be used as biochemical tags, as chemical catalysts, or as laser and optical components.

Small rods of atoms or nanowires are also of interest. These solid, dense structures are built atom by atom in a controlled manner, allowing for impurity doing at for control of the wire's electrical conduction properties.

Nanochemistry also has a use in lab-on-a-chip technologies which are designed to carry out complex chemical processes on an ultra-small scale. Applications might include synthesizing chemicals efficiently, combinatorial chemistry, and biological, chemical, and clinical analyses. It might also find applications in medicine in drug delivery and wound and tissue engineering.

Source link: <https://www.azonano.com/article.aspx?ArticleID=4830>

2. Match the terms (1-31), transcriptions (a-ee), and translations (i-xxxi).

1) adamantane	a) [kju:'kɜ:bɪtərɪl]	i. инфракрасная спектроскопия с Фурье-преобразованием
2) carbon nanofiber (CNF)	b) [ˌnænəʊmə'ni:pjuːləɪtər]	ii. кукурбитурил
3) carbon nanotube (CNT)	c) [ˈfʊəriət'trænsfɔ:m,ɪnfrə'red spæk'trɜskəpɪ]	iii. газовое распыление /атомизация

4) clathrate hydrate	d) [ˈgræfi:n ˈeərə,dʒel]	iv. алмазоид
5) cucurbituril	e) [ˈkwɒntəm,dɒt]	v. графеновый аэрогель (ГА)
6) diamantane	f) [ˈnænəʊʃi:t]	vi. МЭМС-технология; технология микроэлектромеханической системы
7) diamondoid	g) [ˈgæs,ætmɑiˈzeɪf(ə)n]	vii. наноманипулятор
8) flame spray pyrolysis (FSP)	h) [ˈkɑ:b(ə)nˈnænəʊ,faɪbə]	viii. гранулометрический спектр
9) Fourier Transform Infrared Spectroscopy (FTIR)	i) [ˌnænəʊ,pɔːˈsi:kwənsɪŋ]	ix. адамантан
10) fullerene	j) [ˈəʊpənˈkwɒntəmˈsɪstəm]	x. алмадантан
11) gas atomization	k) [ˌædəˈmæntɪn]	xi. углеродное нановолокно
12) granulometric range	l) [ˌnænəʊˈleɪə]	xii. нанослой
13) graphene aerogel (GA)	m) [pɪkˈnɒmətrɪˈdensɪtɪ]	xiii. наносенсор
14) Micro-Electro-Mechanical Systems (MEMS) technology	n) [grænʒuləˈmetɪkˈreɪndʒ]	xiv. пламенно-распылительный пиролиз
15) nanofilm (nanostructured film)	o) [ˈklæθreɪtˈhaɪdreɪt]	xv. углеродная нанотрубка
16) nanolayer	p) [ˈkwɒntəmˌmetəməˈtɪəriəl]	xvi. пикнометрическая плотность
17) nanomanipulator	q) [ˈsɜ:frɪsˈplæzmənˈrezənəns]	xvii. клатратный гидрат
18) nanopore sequencing	r) [ˈkɑ:b(ə)nˈnænəʊ,tʃu:b]	xviii. поверхностный плазмонный резонанс
19) nanosensor	s) [fəʊˈtɒnɪkˈkrɪst(ə)l]	xix. нанопленка
20) nanosheet	t) [ˈfʊlə,rɪ:n]	xx. фуллерен
21) open quantum system	u) [ˌnænəʊˈsensə]	xxi. нанопоровое секвенирование
22) photonic crystal	v) [ˈdɑ:təmən,dɔɪd]	xxii. квантовый метаматериал
23) pycnometry density	w) [ˈkwɒntəmˈwel]	xxiii. нанолист

24) quantum dot	x) ['daɪəmən,teɪn]	xxiv. выборочная лазерная плавка
25) quantum metamaterial	y) [ˌs(j)uːprəməˈleɪkjʊlə]	xxv. открытая квантовая система
26) quantum well	z) ['maɪkrəviˈlektɹəʊmi ˈkæniˌkəlˈsɪstəmzɪtəkˈnɒlədʒɪ]	xxvi. супрамолекулярный
27) selective laser melting (SLM)	aa) [trænzˈvɜːsˈrɪptʃə ,strenθ]	xxvii. сопротивление поперечному разрыву
28) silver nanoparticle (AgNP)	bb) [ˌfleɪmˈspreɪpɑːrɪˌrɒlɪsɪs]	xxviii. фотонный кристалл
29) supramolecular	cc) [ˈnænəʊfɪlm]	xxix. наночастица серебра
30) surface plasmon resonance (SPR)	dd) [ˈsɪlvəˌnænəʊ ˈrɒːtɪk(ə)l]	xxx. квантовая/потенциальная яма
31) transverse rupture strength (TRS)	ee) [sɪˈlektɪvˈleɪzəˈmeltɪŋ]	xxxı. квантовая точка (КТ)

3. For each definition (a-ee) choose a suitable term from task 2 (1-31).

- Cylindrical large molecules consisting of a hexagonal arrangement of hybridized carbon atoms, which may be formed by rolling up a single sheet of graphene.
- A form of carbon having a large molecule consisting of an empty cage of sixty or more carbon atoms in the form of a hollow sphere, ellipsoid, or tube.
- A technology of single-molecule sequencing with the additional potential of detecting epigenetic modifications.
- A potential well that confines particles in one dimension, forcing them to occupy a planar region with only discrete energy values.
- A specific gravity, measured by the pycnometry method.
- A new technology based on self-assembled monolayers (SAMs) where a single layer of a chemical or molecule is absorbed onto the surface of the fiber.
- Any of several polycyclic hydrocarbons whose cagelike structure resembles part of the diamond crystal lattice.
- A polycyclic hydrocarbon, having a cagelike structure similar to a portion of the diamond lattice.
- A diamondoid consisting of two face-fused cages.
- The act of reducing gas particles to atoms, or very minute particles; or the state of being so reduced, separating into fine particles.
- A combination of electronic and mechanical elements, sensors, and active elements on a silicone sub-layer adapting the micro-fabrication technology.
- A nanoscale sheet, especially one of many making up a nanostructure.

- m) A semiconductor whose excitons are confined in all three spatial dimensions; a fluorescent nanoparticle of semiconducting material.
- n) The ability of materials to resist a failure mode in which a tough ductile material pulls apart being across rather than cracking.
- o) A rapid prototyping, 3D printing, or additive manufacturing (AM) technique designed to use a high power-density laser to melt and fuse metallic powders.
- p) A periodic optical nanostructure that affects the motion of photons in much the same way that ionic lattices affect electrons in solids.
- q) A microscope coupled to a virtual-reality interface that allows the operator virtual telepresence on the sample surface. This apparatus affords a new approach for interacting with materials and objects at the nanometer scale in real-time during an experiment.
- r) A substance formed by the suspension of small bubbles of gas in solid carbon consisting of a film of graphite one atom thick.
- s) Crystalline water-based solid physically resembling ice, in which small non-polar molecules (typically gases) or polar molecules with large hydrophobic moieties are trapped inside "cages" of hydrogen-bonded, frozen water molecules.
- t) Any nanostructure of graphene layers arranged as stacked cones, cups, or plates.
- u) Any of a class of macrocyclic molecules consisting of glycoluril repeat units linked by methylene bridges.
- v) An approved interfacial layer between particles and base fluid involved in modeling for effective thermal conductivity and effective viscosity of nanofluids.
- w) Any biological, chemical, or surgical sensory points used to convey information about nanoparticles to the macroscopic world; a class of sensor devices or systems in which a nanoscale interaction is exploited as the basis of detecting the presence or level of a known analyte.
- x) Nanometer-sized silver (soft white precious univalent metallic element having the highest electrical and thermal conductivity of any metal) particles that are nanoscale in three dimensions.
- y) A spectroscopic method used to detect protein interactions by immobilizing the ligand on a thin metal film and measuring the change in refractive index upon binding of the analyte.
- z) A quantum-mechanical system that interacts with an external quantum system, the environment or bath, these interactions significantly change the dynamics of the system and result in quantum dissipation, where the information contained in the system is lost to its environment.
- aa) A process in which a thin film is deposited by atomizing and spraying a solution on a heated surface, where the constituent reacts to form a chemical compound;

this spray is heated by a flame produced by an oxy-acetylene gas mixture, before being deposited onto the substrate.

- bb) Size distribution of grains in binary images, using a series of morphological opening operations.
- cc) Concerning chemical systems composed of a discrete number of molecules.
- dd) A metamaterial (artificial material engineered to have properties that may not be found in nature) in which certain quantum properties of the medium must be taken into account and whose behavior is thus described by both Maxwell's equations and the Schrödinger equation.
- ee) A measurement technique whereby spectra are collected based on measurements of the coherence of a radiative source, using time-domain or space-domain measurements of the electromagnetic radiation or other types of radiation, in this technique a Fourier transform is required to turn the raw data into the actual spectrum, and in many of the cases in optics involving interferometers, is based on the Wiener-Khinchin theorem.

4. Complete the paragraphs using the terms studied in this unit (task 2). In some sentences the plural form is required. In each paragraph, the same word is missing.

- a) For aluminum and its alloys, _____ is widely used in industry. The conventional process provides cooling rates up to 10^5 K/s. However, the _____ technology is a dangerous process and special safety measures are required, which considerably raises the manufacturing costs. Inert _____ enables beryllium powder to be produced in semi-manufactured condition without a chip-forming step. Parallel with this, the major advantage of this process over the conventional impact ground powder technique is the increased isotropy of the consolidated material. In _____, the stream of liquid metal is disrupted by a high-velocity gas (air, nitrogen, argon, or helium). Worldwide annual tonnage of _____ powders is much less than that of water atomized powders: about $300,000 \text{ t yr}^{-1}$ for air atomization and $50,000 \text{ t yr}^{-1}$ for inert _____ of nonferrous alloys. Melt size and melt feed rate ($<120 \text{ kg min}^{-1}$) are lower than in water atomization.
- b) A practical technology scouting approach is employed to introduce the newest and most important applications of the _____ in the automotive industry. In recent years, _____ with a broad variety of _____ sensors has been used widely in the automotive industry, so that at least 30 sensor nodes of a modern vehicle with 100 sensor nodes are _____ and the automotive industry is the second market of _____.

- c) _____ have various applications in the environmental field. The ability to sense for chemicals and biological agents that are present in the air and water is a concern to environmental agencies. _____ will innovate the ways air and water quality is measured due to their size, quickness, and accuracy of measurements. An example of this is detecting mercury in any medium (such as air and water) through the use of dandelion-like Au/polyaniline nanoparticles in conjunction with surface-enhanced Raman spectroscopy _____.
- d) The term “decoherence” in a wider sense takes into account all possible effects of environmental influence on the _____. Macroscopic systems may be considered as quantum subsystems, that is, nonisolated, _____ which are under inevitable interaction with the other physical systems which constitute the environment. In this regard, microscopic systems are physical systems that experience a “short” time interaction, for example, the action of an incident or external field, or the potential energy of the system. Under these circumstances, such systems are isolated.
- e) _____, while enabling kinetic control of metastable polymorphs, is also a very effective and scalable industrial process to synthesize oxide nanoparticles in large quantities while maintaining excellent product quality. It has been used for the dry, one-step synthesis of catalysts, sensors, biomaterials, phosphors, and even nutritional supplements, each of which would require high-quality metastable materials to ensure the desired functionality and provides a precedent for _____ synthesized material quality. _____ has a high processing temperature (as high as 2800K) and the highest gas flow rate of most oxide processing techniques. Based on these two factors, _____ is the only processing method that can provide very short residence times in the highest temperature gradient region and is thus a powerful synthesis method for the production of metastable species through kinetic control.
- f) _____ and polymer nanofibers in composites have been critically reviewed in this chapter. The concept, methodology, potential applications, advantages, and limitations of utilizing nanofibers in composite materials are discussed. The important application examples reviewed include _____ and polymer nanofibers in structural carbon fiber reinforced polymer matrix composites, polymer nanofiber-reinforced nanocomposites for medical use, and modification of thermosetting polymer by polymer/_____ composite nanofibers. A brief account is also given of the future trends in this area.
- g) _____ (also called congressane) is an organic compound that is a member of the diamondoids. These are cage hydrocarbons with structures similar to a subunit of the diamond lattice. It is a colorless solid that has been a topic of research since its discovery in oil and separation from deep natural gas condensates. Diamondoids such as _____ exhibit unusual properties, including low surface energies, high

densities, high hydrophobicities, and oxidation resistance. _____ occurs naturally in crude petroleum.

- h) _____ are quite elastic and can easily retain their original form after some compression. In addition, the low density of _____ makes them very absorbent (to the point where it can even absorb more than 850 times its weight). This means that it could be useful for environmental clean-ups like oil spills, and _____ only need to be picked up later after absorbing the spilled material. _____ may also have some applications in both the storage and the transfer of energy by enabling the creation of lighter, higher-energy-density batteries - and vigorous research is being done on the matter.
- i) _____ are formed at different interfaces between heterogeneous or homogeneous phases of gas, liquid, or solid state, depending on the procedure. _____ are one of the most important fields within nanotechnology. Through nanoscale engineering of surfaces and layers, a vast range of functionalities and new physical effects (e.g. magnetoelectronic or optical) can be achieved. Furthermore, a nanoscale design of surfaces and layers is often necessary to optimize the interfaces between different material classes (e.g. compound semiconductors on silicon wafers) and to obtain the desired special properties.
- j) _____ is the fourth-generation DNA sequencing technology and the significant advantages of nanopores (biological or solid-state) include label-free, ultralong reads, high throughput, and low material requirement. Each of these greatly simplifies the experimental process and can be easily used for DNA sequencing applications. Using _____, a molecule of DNA or RNA can be sequenced without the need for PCR amplification or chemical labeling of the sample.
- k) _____ occur in nature in the form of structural coloration and animal reflectors, and, in different forms, promise to be useful in a range of applications. In 1887 the English physicist Lord Rayleigh experimented with periodic multi-layer dielectric stacks, showing they had a photonic band-gap in one dimension. Research interest grew with work in 1987 by Eli Yablonovitch and Sajeev John on periodic optical structures with more than one dimension – now called _____. _____ can be fabricated for one, two, or three dimensions.
- l) A _____ can be implemented as a quantum coherent 1D array of qubits placed in a transmission line. The properties of _____ are determined by the local quantum state of the system. Here we show that a spatially-periodic quantum state of such a system can be realized without direct control of the constituent qubits, by their interaction with the initializing ("priming") pulses sent through the system in opposite directions. The properties of the resulting quantum photonic crystal are determined by the choice of the priming pulses. This proposal can be readily generalized to other implementations of _____.

- m) _____ chemistry is defined as chemistry beyond the molecule. This research field was initialized in the last century by many researchers in combined research fields, including Nobel Prize winners Lehn, Cram, and Pedersen. One of them, Lehn, invented the word supermolecule, whereby _____ chemistry is chemistry beyond the molecule bearing on the organized entities of higher complexity that result from the association of two or more chemical species held together by intermolecular forces. _____ structures are a result of various noncovalent interactions, including van der Waals interaction, electrostatic interaction, hydrogen bonding, hydrophobic interaction, coordination, etc., some of which are often cooperatively working in one _____ complex. More importantly, properties of the formed _____ complexes are far beyond the summation of the individual components.
- n) A _____, in the context of building materials for nanotechnology components, most generally refers to structures that resemble diamond in a broad sense: namely, strong, stiff structures containing dense, 3-D networks of covalent bonds, formed chiefly from first and second-row atoms with a valence of three or more. Examples of _____ structures would include crystalline diamond, sapphire, and other stiff structures similar to diamond but with various atom substitutions which might include N, O, Si, S, and so forth. sp^2 -hybridized carbon structures that – in contrast to sp^3 -hybridized carbon in diamond – arrange in planar sheets are sometimes also included in the class of _____ materials for nanotechnology, e.g., graphite, carbon nanotubes consisting of sheets of carbon atoms rolled into tubes, spherical buckminsterfullerenes, and other graphene structures.
- o) _____ occur in nature. More recently, _____ have been detected in outer space. The discovery of _____ greatly expanded the number of known carbon allotropes, which until recently were limited to graphite, diamond, and amorphous carbon such as soot and charcoal.
- p) _____ are ice-like inclusion compounds that form at high pressures and low temperatures with nonpolar guest molecules surrounded by hydrogen-bonded water cages. Hydrates apply to wide ranges of industrial and scientific environments comprising modeling of climate change, CO_2 sequestration, hydrocarbon extraction, natural gas and hydrogen storage, refrigeration and separation technologies, planetary surface chemistry, and marine biology.
- q) _____ can be made self-repairable by engineering a storage source within the nanolayers. When material in the top layer is removed by, for example, abrasion, electrostatic interactions will try to neutralize the charge on the surface where the material was removed. Multifunctional bioactive _____, with an excellent combination of chemical, mechanical, tribological, and biological properties, were developed and deposited by sputtering of composite targets produced via the self-propagating high-temperature synthesis method. Reviewed substrate materials included

Ti-, Ni-, and Co-based alloys, bio-insoluble polymers, and decellularized donor's bones.

- r) Freestanding and atomically thin gold _____ with a thickness of only 0.47 nm are synthesized via a one-step aqueous approach at 20 °C, using methyl orange as a confining agent. Owing to the high surface-area-to-volume ratio, the abundance of unsaturated atoms exposed on the surface, and large interfacial areas arising from their ultrathin 2D nature, the as-prepared Au _____ demonstrate excellent catalysis performance in the model reaction of 4-nitrophenol reduction, and remarkable peroxidase-mimicking activity, which enables a highly sensitive colorimetric sensing of H₂O₂ with a detection limit of 0.11×10^{-6} M.
- s) _____ were discovered in the early 1980s by Alexei Ekimov in a glass matrix and by Louis E. Brus in colloidal solutions. The term " _____ " was coined by Mark Reed. Researchers have studied applications for _____ in transistors, solar cells, LEDs, and diode lasers. They have also investigated _____ as agents for medical imaging and as possible qubits in quantum computing. _____ are semiconductors whose electronic characteristics are closely related to the size and shape of the individual crystal.
- t) _____ have attracted increasing interest due to their chemical stability, catalytic activity, localized surface plasma resonance, and high conductivity. In addition, _____ hold great potential in preventing wound inflammation and hence promoting wound healing in the form of topical administration.
- u) _____ is the basic principle for many colorimetric assays and is induced when the frequency of incident photons complements the natural frequency of surface electron oscillations against the attraction to the positive nuclei. _____ biosensors exploit special electromagnetic waves to probe changes in the refractive index at surfaces of metals. _____ biosensors can therefore be used to monitor the interaction between an analyte in solution and its biospecific partner immobilized on the metal surface without the use of labels.
- v) Since the designed _____ is for micro-scaled applications compatible with the conventional micro-fabrication processes, polysilicon is chosen as its material. For identification of the _____, a three-layer neural network is used.
- w) _____ is a colorless, crystalline chemical compound with a camphor-like odor. With a formula C₁₀H₁₆, it is a cycloalkane and also the simplest diamondoid. _____ molecules consist of four connected cyclohexane rings arranged in the "armchair" configuration. It is unique in that it is both rigid and virtually stress-free. _____ is the most stable among all the isomers with formula C₁₀H₁₆.
- x) _____ is a nonadecacyclic cage compound consisting of six tetrazocane units fusing six glycoluril moieties. It is readily synthesized from urea, glyoxal, and formaldehyde. _____ readily encapsulates and binds, in its internal cavity, substituted

ammonium ions having dimensions smaller than a para-disubstituted benzene ring. Acting as a Pauling Principle catalyst, _____ was found to accelerate a 1,3-dipolar addition reaction.

- y) Cobalt-chromium-molybdenum alloy was used to overview gas-atomized powder properties in different _____ (D1 12 - 19 μm , D2 20 - 46 μm and D3 76 - 106 μm). Selective laser melting manufactured standard tensile specimens of usually _____ powder size provided mechanical, chemical, and thermal properties of biocompatible Co-Cr-Mo alloy.
- z) _____ can be divided into single-walled _____ and multiwalled _____ according to their structure. However, _____ are liable to contamination from the metal catalysts during the preparation process. The purity of _____ is thus very important. Currently, the most widely used preparation method of _____ is the chemical vapor deposition, which is relatively cheap and can be used to synthesize _____ in large quantities. The physicochemical properties of _____ are similar to those of graphene, including high mechanical strength, excellent thermal and electrical conductivity, and light absorption over a wide range of wavelengths. The apparent difference is that _____ have high aspect ratios while graphene has a layered structure.
- aa) _____ is a technique used to obtain an infrared spectrum of absorption, emission, photoconductivity, or Raman scattering of a solid, liquid, or gas. An _____ spectrometer simultaneously collects spectral data in a wide spectral range. This confers a significant advantage over a dispersive spectrometer that measures intensity over a narrow range of wavelengths at a time.
- bb) _____ is a single period superlattice structure consisting of two energy barriers confining an electron in-between the barriers. The idea of utilizing a _____ for infrared detection was first presented by Esaki and Sakaka in 1977 and can be explained by using the basic principles of quantum mechanics. The _____ is equivalent to the well-known particle in a box problem in quantum mechanics, which can be solved by the time-independent Schrödinger equation. The solutions to this problem are the eigenvalues that describe energy levels inside the quantum well in which the particle is allowed to exist.
- cc) Powders characteristics as a granulometric size, particle format, flow rate, apparent, tap, theoretical, and helium _____ were evaluated. The open porosity is discounted in the _____.
- dd) The _____ is a technology that can manufacture 3D components by laser beam action that completely melts a powder bed layer until the final geometry. Traditional _____ machines have a maximum laser power of 400 W with a laser focus diameter of 100 μm . _____ process occurs layer by layer using a feedstock as a metal powder that is stored in a container that may be the distributor of

powder (deposited by gravity), which turn to uniform the powder layer (between 20 to 100 μm) on the build platform.

- ee) The mechanical properties such as hardness fracture toughness and _____ of different WC-Co grades were investigated. The _____ was measured through the three-point bend test. Due to the wide scatter of _____ values, the obtained results were analyzed within the Weibull theory.

5. Make words or word combinations by putting the entangled letters in the correct order. Then make up 15 compound terms, which consist of two or more words.

- | | |
|---------------------------|-------------------------|
| 1) rbncao | a) rdyahet |
| 2) arcnbo | b) mstsoeenltsycghyo |
| 3) eaalctrth | c) geiesqcnnu |
| 4) peflsmaya | d) neteptthrrrguus |
| 5) urrmeoffroansitr | e) ysndeit |
| 6) litmorauceng | f) ytacslr |
| 7) canmircrmeoethcoilecal | g) ocseerann |
| 8) rnoponea | h) nbeafnoir |
| 9) eouapqnmtn | i) mnieglt |
| 10) opotcihn | j) mrimtetaalea |
| 11) coemnypry | k) slrsyoyip |
| 12) tunmauq | l) grnea |
| 13) itseclvleresea | m) arosctdipfroenryecsp |
| 14) rufsomnsapclae | n) abnuonte |
| 15) tvnsearrs | o) ytmsse |

6. Translate the sentences into Russian. The words in bold should be taken from the unit's list of terms.

- 1) **Adamantane** derivatives have found practical application as drugs, polymeric materials, and thermally stable lubricants.

- 2) **Carbon nanofibers** can be prepared in relatively large quantities using a variety of metals either in a powdered or supported form as catalytic entities.
- 3) Due to its unique structure and molecular recognition properties, **cucurbituril** has been used in numerous supramolecular architectures, as building blocks in rotaxanes, catenanes, or molecular machines.
- 4) **Diamantane** can be nitrated by treatment with nitronium tetrafluoroborate (in nitrile-free nitromethane) to give a mixture of two isomeric nitrodiamantanes.
- 5) Functional metal oxides can exist as different polymorphs. Meta stable phases of these oxides may be produced by **flame spray pyrolysis (FSP)**. This is a scalable, rapid solidification process that may be used for nanopowder synthesis.
- 6) The particles in the study produced by **gas atomization** showed spherical particle geometry with satellites and internal porosity.
- 7) Layer-by-layer (LBL) **nanofilms** have demonstrated value in many specific applications of coatings. These films can be fabricated on glass, metals and alloys, ceramics, polymers, and their compounds using a dipping technique to modify the performance (e.g. corrosion, biological, optical, electrical, tribological, thermal, magnetic, and electrostatic) of the materials and also to protect the surface from environmental effects. LBL films can be applied easily to clean surfaces.
- 8) Presently, there are several ways proposed to make **nanosensors**, including top-down lithography, bottom-up assembly, and molecular self-assembly.
- 9) The **quantum well** structure is designed so that these photoexcited carriers can escape from the **quantum well** and can be collected as photocurrent.
- 10) **Supramolecular** chemistry is the discipline covering “the chemistry of molecular assemblies and the intermolecular bond” and deals with “organized entities that result from the association of two or more chemical species held together by intermolecular forces.
- 11) **Surface plasmon resonance** is an optical technique that is utilized for detecting molecular interactions, such as interactions that occur between proteins or other classes of molecules.
- 12) Based on their good antimicrobial function and nontoxicity, **silver nanoparticles** have been used as an effective topical application for improving wound healing.

7. Complete the paragraphs using the terms studied in this unit (task 2) again. In some sentences the plural form is required. In each paragraph, the same word is missing.

- a) Because no quantum system is completely isolated from its surroundings, it is important to develop a theoretical framework for treating these interactions to obtain an accurate understanding of quantum systems. Techniques developed in the context of _____ have proven powerful in fields such as quantum optics, quantum measurement theory, quantum statistical mechanics, quantum information science, quantum thermodynamics, quantum cosmology, quantum biology, and semi-classical approximations.
- b) _____ is a cyclic hexamer of dimethanoglycoluril synthesized from the acidic condensation of glycoluril and excess formaldehyde. It was first mentioned in 1905 by Behrend et al., but it was not until 1981 when Mock et al. fully characterized its chemical structure and coined the term “_____” based on its resemblance to a pumpkin.
- c) _____ technologies can be generally classified into four categories: accelerometers, gyroscopes, and inclinometers; flow and pressure sensors; emerging applications like the IR sensors for air quality and micro-scanners for vehicle displays, etc.; as well as other applications such as the _____ oscillators, and energy scavengers for TMPS. Any of these categories involves different applications to address the specific objectives in the vehicle.
- d) _____ have been recognized with tremendous interest due to their larger SSA, ultralow densities, and high electrical conductivity. Some admirable research has been reported on large-scale _____. Jiang et al. fabricated _____ micro lattices with dimensions of several centimeters by a direct 3D printing method.
- e) In _____ an aqueous metal salt solution is sprayed as a fine mist, through a capillary and into a flame. Then, small droplets are formed while the solvent burns inside the flame. The conversion of the salt into the metal oxide occurs upon the pyrolysis reaction and the metal oxide atoms aggregate into nanoparticles, which are then collected on a substrate. It is possible to observe a schematic of _____ synthesis that can be used to produce metal oxide nanoparticles.
- f) On the _____ investigation, the evaluation of layers is requested rather than overall particle structure. Although the _____ thickness can be evaluated from AFM, surface plasmon resonance, quartz crystal microbalance, and ellipsometry, these techniques are not sufficient for investigating the internal fine structure in _____.
- g) _____ refers to variants of the carbon cage molecule known as adamantane ($C_{10}H_{16}$), the smallest unit cage structure of the diamond crystal lattice. _____ may include one or more cages (adamantane, diamantane, triamantane, and higher

polymantanes) as well as numerous isomeric and structural variants of adamantanes and polymantanes. _____ occur naturally in petroleum deposits and have been extracted and purified into large pure crystals of polymantane molecules having more than a dozen adamantane cages per molecule.

- h) _____ are mainly investigated as orthopedic, dental, and neural tissue engineering scaffolds based on their exceptional material characteristics, including their tensile strength which approximates that of bone, electrical conductivity which renders them suitable materials for nerve regeneration, biocompatibility profiles surpassing that of conventional metal alloy implants, and non-toxicity in terms of metal ion leachables.
- i) _____ are ice-like materials that belong to the category of inclusion compounds. They consist of a solid network of hydrogen-bonded water molecules that form cavities engaging various “guest” molecules such as methane, carbon dioxide, or small hydrocarbon chains.
- j) A _____ is any molecule composed entirely of carbon, in the form of a hollow sphere, ellipsoid, or tube. Spherical _____ are also called buckyballs, and they resemble the balls used in football. Cylindrical ones are called carbon nanotubes or buckytubes. _____ are similar in structure to graphite, which is composed of stacked graphene sheets of linked hexagonal rings; but they may also contain pentagonal rings.
- k) _____ can also be used in monitoring water distribution and water quality. Due to the loss of water from leaky pipes and mains, the Environmental Protection Agency has designed an innovative way to improve the water supply infrastructure via a highly cost-effective monitoring system.
- l) _____ chemistry has developed from early host-guest chemistry to self-assembly of small, low molecular building blocks to larger _____ aggregates both in solution, in the solid state, and at interfaces. The resulting (nano)objects have contributed to the new field of nanotechnology.
- m) The development of _____ with tailored properties is of significance for a diverse range of applications in areas such as energy, biomedicine, and optics. The ability to finely control the properties of such films is vital to achieving optimum performance for each application. For instance, surfaces for drug delivery applications need to be carefully tailored to have a stealth response in vivo or the effectiveness of their delivery is limited.
- n) _____ can be produced by the thermal cracking of long-chained n-alkanes. The mechanism for this conversion is thought to be a free-radical addition. Although this method does produce _____ that has been alkylated (i.e. monosubstituted, disubstituted, and trisubstituted with methyl groups), adamantane derivatives are also produced in greater amounts due to its greater thermodynamic stability.

- o) _____ has the potential to offer relatively low-cost genotyping, high mobility for testing, and rapid processing of samples with the ability to display results in real-time. _____ uses electrophoresis to transport an unknown sample through an orifice of 10^{-9} m in diameter.
- p) _____ are periodic dielectric structures that are designed to form the energy band structure for photons, which either allows or forbids the propagation of electromagnetic waves of certain frequency ranges, making them ideal for light-harvesting applications.
- q) In a more strict approach, a _____ should demonstrate coherent quantum dynamics. Such a system is essentially a spatially extended controllable quantum object that allows additional ways of controlling the propagation of electromagnetic waves. _____ can be narrowly defined as optical media that: Are composed of quantum coherent unit elements with engineered parameters; Exhibit controllable quantum states of these elements; Maintain quantum coherence for longer than the traversal time of a relevant electromagnetic signal.
- r) Biomaterial powders are in high development due to the expansion of additive manufacturing (AM) processes. _____ is a particular AM technology, which completely melts a powder bed layer by a laser beam.
- s) _____ is a powerful analysis tool for characterizing and identifying organic molecules. It is the spectroscopic technique that is the most widely used for determining the characteristics of new membranes. In attenuated total reflectance mode, this type of spectroscopy enables functional groups present over a depth of about 1 μm to be identified.
- t) _____ have superior mechanical, electrical, and thermal properties but their nanoscale dimensions restrict their applications. _____ yarns, being microscopic fiber-like and continuous assemblies of _____, offer a much wider range of applications. The unique piezoresistive response of _____ yarns can be tapped for sensing applications including strain measurement, damage detection, torque measurement, and motion monitoring as well as temperature measurement and detection of various chemicals.

8. Translate the sentences into English. The words in bold should be taken from the unit's list of terms.

- 1) **Клатратные гидраты** немного похожи на цеолиты, поскольку они заключают в себе небольшие молекулы газа в рамках связанных водородом молекул воды.
- 2) **Диамантан** входит в состав семейства **диамантоидов**. Структуры этих элементов являются сегментами кристаллической решетки алмаза.

- 3) **Алмазоиды** содержатся в зрелых высокотемпературных нефтяных жидкостях (летучие масла, конденсаты и влажные газы).
- 4) В способе **пиролиза пламенным распылением** оксидные тонкие пленки непосредственно осаждаются на подложку путем испарения и разложения распыленных жидких прекурсоров при высоких температурах с использованием пламени для достижения газофазной реакции с образованием частиц с последующим осаждением наночастиц методом термофореза.
- 5) Твердость порошков по отношению к **гранулометрическому диапазону** от процесса **распыления газа**, измерения микротвердости были выполнены на образцах порошка Co-Cr-Mo.
- 6) Использование **нанослоев** в качестве наноаддитивов является наиболее распространенным типом нанокомпозитов. Основным преимуществом, ожидаемым от добавления двумерных наноаддитивов, является, наряду с общим для нановолокон усиливающим эффектом, увеличение барьерных свойств. Этот факт делает слоистые нанокомпозиты наиболее перспективными для пищевой упаковочной промышленности.
- 7) **Нано-манипулятор** включает в себя центральную ступень, прикрепленную к трем звеньям, соединенным с микрошкальными приводами изгибными шарнирами.
- 8) **Фотонный кристалл** - это оптическая аналогия с кристаллической решеткой, где атомы или молекулы периодически расположены, и периодический потенциал вносит пробелы в структуру энергетической полосы кристалла.
- 9) **Квантовые метаматериалы** расширяют науку о метаматериалах до квантового уровня. Они могут управлять электромагнитным излучением, применяя правила квантовой механики.
- 10) **Супрамолекулярная** химия оказалась мощным инструментом для изучения наноразмерных структур, имитирующих сложные биологические системы в живых организмах.
- 11) Известно, что благородные металлы проявляют уникальные оптические свойства, обусловленные свойством **поверхностного плазмонного резонанса**.
- 12) **Селективная лазерная плавка** позволяет производить функциональные компоненты с высокой структурной целостностью при низких затратах и совместима с различными материалами, в том числе биосовместимыми титановыми сплавами.

9. Find 22 hidden terms in the word search puzzle. The terms are directed forward →, back ←, down ↓, up ↑ and diagonally ↘, ↙, ↖, ↗. There are terms made up of one, two, or more words. The words do not belong together, but they are fused in the puzzle. One of the terms is marked.

t	e	a	r	o	s	n	e	s	o	n	a	n	f	h	n	n	x	g	e
s	k	l	a	l	u	h	c	v	e	t	d	h	v	o	a	g	n	g	e
i	v	i	e	n	a	t	n	a	m	a	i	d	i	n	r	i	n	p	t
s	g	r	r	n	c	z	v	e	d	m	s	t	o	a	c	a	h	s	a
y	h	u	e	a	i	f	m	d	b	n	a	m	p	n	r	o	u	k	r
l	e	t	y	n	z	h	j	l	b	z	a	h	e	c	t	p	o	l	d
o	n	i	a	o	a	g	c	x	i	n	e	u	i	o	r	b	t	r	y
r	t	b	l	f	s	a	v	m	i	n	q	r	n	a	y	v	d	m	h
y	o	r	o	i	m	g	o	p	e	e	t	i	m	g	b	d	o	d	e
p	d	u	n	l	s	t	u	a	s	e	c	o	o	p	f	e	p	n	t
y	m	c	a	m	a	l	e	e	m	c	l	g	j	p	c	a	t	m	a
a	u	u	n	s	a	r	r	o	r	e	o	h	r	l	y	b	a	e	r
r	t	c	a	t	o	o	l	y	c	e	n	e	r	e	l	l	u	f	h
p	n	g	o	g	p	u	s	u	i	t	e	n	f	s	b	t	d	i	t
s	a	r	e	o	n	t	l	d	i	a	m	o	n	d	o	i	d	t	a
e	u	l	n	a	a	a	u	h	n	a	n	o	s	h	e	e	t	e	l
m	q	a	r	l	r	r	k	e	n	a	t	n	a	m	a	d	a	a	c
a	n	g	p	y	c	n	o	m	e	t	r	y	d	e	n	s	i	t	y
l	m	e	t	s	y	s	m	u	t	n	a	u	q	n	e	p	o	p	m
f	e	l	c	i	t	r	a	p	o	n	a	n	r	e	v	l	i	s	j

10. Reading and discussion.

a) Read the text and say where DNA motors can be used.

New DNA origami motor breaks speed record for nanomachines. Scientists pave way for 'nano bots' to one day diagnose and treat disease

Source link: <https://www.sciencedaily.com/releases/2020/03/200303140149.htm>

Date: March 3, 2020

Source: Emory Health Sciences

Summary: Through a technique known as DNA origami, scientists have created the fastest, most persistent DNA nano motor yet. New findings provide a blueprint for how to optimize the design of motors at the nanoscale - hundreds of times smaller than the typical human cell.

“Nanoscale motors have tremendous potential for applications in biosensing, in building synthetic cells, and also for molecular robotics,” says Khalid Salaita, a senior author of the paper and a professor of chemistry at Emory University. “DNA origami allowed us to tinker with the structure of the motor and tease out the design parameters that control its properties.”

The new DNA motor is rod-shaped and uses RNA fuel to roll persistently in a straight line, without human intervention, at speeds up to 100 nanometers per minute. That's up to 10 times faster than previous DNA motors.

Salaita is also on the faculty of the Wallace H. Coulter Department of Biomedical Engineering, a joint program of Georgia Institute of Technology and Emory. The paper is a collaboration between the Salaita lab and Yonggang Ke, assistant professor at Emory's School of Medicine, and the Wallace H. Coulter Department of Biomedical Engineering.

“Our engineered DNA motor is fast,” Ke says, “but we still have a long way to go to achieve the versatility and efficiency of nature's biological motors. Ultimately, the goal is to make artificial motors that match the sophistication and functionality of proteins that move cargo around in cells and allow them to perform various functions.”

Making things out of DNA, nicknamed DNA origami after the traditional Japanese paper folding craft, takes advantage of the natural affinity for the DNA bases A, G, C, and T to pair up with one another. By moving around the sequence of letters on the strands, researchers can get the DNA strands to bind together in ways that create different shapes. The stiffness of DNA origami can also easily be adjusted, so they remain straight as a piece of dry spaghetti or bend and coil like boiled spaghetti.

Growing computational power, and the use of DNA self-assembly for the genomics industry, have greatly advanced the field of DNA origami in recent decades. Potential uses for DNA motors include drug delivery devices in the form of nanocapsules that open up when they reach a target site, nanocomputers, and nanorobots working on nanoscale assembly lines.

“These applications may seem like science fiction now, but our work is helping move them closer to reality,” says Alisina Bazrafshan, an Emory Ph.D. candidate and first author of the new paper.

One of the biggest challenges of DNA motors is the fact that rules governing motion at the nanoscale are different than those for objects that humans can see. Molecular-scale devices must fight their way through a constant barrage of molecules. These forces can cause such tiny devices to drift randomly like grains of pollen floating on the surface of a river, a phenomenon known as Brownian motion.

The viscosity of liquids also makes a much larger impact on something as tiny as a molecule, so the water becomes more like molasses.

Many prior DNA motors ‘walk’ with a mechanical leg-over-leg motion. The problem is that two-legged versions tend to be inherently unstable. Walking motors with more than two legs gain stability but the extra legs slow them down.

The Emory researchers solved these problems by designing a rod-shaped DNA motor that rolls. The rod, or “chassis” of the motor consists of 16 DNA strands bound together in a four-by-four stack to form a beam with four flat sides. Thirty-six bits of DNA protrude from each face of the rod, like little feet.

To fuel its motion, the motor is placed on a track of RNA, a nucleic acid with base pairs that are complementary to DNA base pairs. The RNA pulls at the DNA feet on one face of the motor and binds them to the track. An enzyme that targets the only RNA that is bound to DNA then quickly destroys the bound RNA. That causes the motor to roll, as the DNA feet on the next face of the motor get pulled forward by their attraction to RNA.

The rolling DNA motor forges a persistent path, so it continues to move in a straight line, as opposed to the more random motion of walking DNA motors. The rolling motion also adds to the new DNA motor's speed: It can travel the length of a human stem cell within two or three hours. Previous DNA motors would need about a day to cover that same distance, and most lack the persistence to make it that far.

One of the biggest challenges was measuring the speed of the motor at the nanoscale. That problem was solved by adding fluorescent tags on either end of the DNA motor and optimizing imaging conditions on a fluorescent microscope.

Through trial and error, the researchers determined that a stiff rod shape was optimal for moving in a straight line and that 36 feet on each face of the motor provided optimal density for speed.

“We provided a tunable platform for DNA origami motors that other researchers can use to design, test, and optimize motors to further advance the field,” Bazrafshan says. “Our system allows you to test the effects of all kinds of variables, such as chassis shape and rigidity and the number and density of legs to fine-tune your design.”

b) Circle the word or phrase to make true statements.

1. The new DNA motor has a speed of *two hundred/one hundred* meters per minute.
2. The purpose of the work is to *create/copy* motors like real proteins.
3. DNA origami makes use of the natural affinity for the DNA bases *A/B, G/D, C,* and T to pair up with one another.
4. In recent decades, the ever-growing data *processing/production* facilities have greatly promoted the development of DNA origami.
5. Bipedal versions of DNA motors are usually *stable/not stable*.

c) Match the terms and their definitions.

Term	Definition
1. cell	a) the chemical, present at the centre of the cells of living things
2. RNA	b) relating to the complete set of genetic material of a living thing
3. DNA	c) the smallest basic unit of a plant or animal
4. genomic	d) a type of acid that exists in all living cells
5. DNA origami	e) one of the most recent techniques of utilizing DNA as building blocks for synthesis of nanoparticles
6. nucleic acid	f) the simplest unit of a chemical substance, usually a group of two or more atoms
7. molecule	g) an important chemical present in all living cells
8. drug	h) a chemical used as a medicine

d) Visit one of the websites <https://academic.oup.com/>, <http://abc-chemistry.org/>, <http://www-jmg.ch.cam.ac.uk/data/c2k/cj/> or any other website publishing research articles in Chemistry, choose an article, read and summarize its content using the plan and useful phrases in the Appendix. The length of the summary should be about 10 % of the original text.

Unit 10. Biochemistry and Biotechnology

1. Read the texts and say what biochemistry and biotechnology have in common. In what way are these scientific fields connected with chemistry and biology?

Biochemistry (once known as **physiological chemistry** or **biological chemistry**) is the study of chemicals and chemical processes that occur in living organisms. It involves the investigation of the structures, functions, and syntheses of biological substances, including proteins, DNA, RNA, carbohydrates, lipids, nucleotides, and amino acids. Research in biochemistry has revealed the functions of groups of materials such as enzymes, hormones, vitamins, and minerals. It has led to detailed descriptions of cellular structures such as membranes and chromosomes, and the molecular processes involved in metabolism, genetics, energy production, membrane transport, and signal transduction. Biochemistry has helped us understand nutritional and medical issues, greatly expanding the repertoire of treatments available for various diseases.

Biochemists have been able to produce a variety of substances found in living organisms, and they have shown that there is a continuity of both chemicals and chemical principles that operate in living and nonliving systems. However, how living organisms originated from nonliving matter remains a mystery.

Biochemists increasingly combine specific techniques native to biochemistry with techniques and ideas from genetics, molecular biology, and biophysics.

Genetics is the study of the effect of genetic differences on organisms. Often this can be inferred by the absence of a normal component (for example, one gene). The study of "mutants" – organisms that lack one or more functional components concerning the so-called "wild type" or normal phenotype. Genetic interactions (epistasis) can often confound simple interpretations of such "knock-out" studies.

Molecular biology is the study of molecular underpinnings of the process of replication, transcription, and translation of the genetic material. The central dogma of molecular biology where genetic material is transcribed into RNA and then translated into protein, despite being an oversimplified picture of molecular biology, still provides a good starting point for understanding the field. This picture, however, is undergoing revision in light of emerging novel roles for RNA.

Chemical Biology seeks to develop new tools based on small molecules that allow minimal perturbation of biological systems while providing detailed information about their function. Further, chemical biology employs biological systems to create non-natural hybrids between biomolecules and synthetic devices (for example, emptied viral capsids that can deliver gene therapy or drug molecules).

Biotechnology, in its broadest sense, is the use of biological systems to carry out technical processes. Food biotechnology uses genetic methods to enhance food properties

and to improve production, and in particular, uses direct (rather than random) strategies to modify genes that are responsible for traits such as a vegetable's nutritional content. Using modern biotechnology, scientists can move genes for valuable traits from one plant into another plant. This way, they can make a plant taste or look better, be more nutritious, protect itself from insects, produce more food, or survive and prosper in inhospitable environments, for example, by incorporating tolerance to increased soil salinity. Simply put, food biotechnology is the practice of directing genetic changes in organisms that produce food to make a better product.

In nature, plants produce their chemical defenses to ward off disease and insects thereby reducing the need for insecticide sprays. Biotechnology is often used to enhance these defenses. Some improvements are crop-specific. For example, potatoes with a higher starch content will absorb less oil when frying, and tomatoes with delayed ripening qualities will have improved taste and freshness.

Bioengineering is the science upon which all Biotechnological applications are based. With the development of new approaches and modern techniques, traditional biotechnology industries are also acquiring new horizons enabling them to improve the quality of their products and increase the productivity of their systems.

Before 1971, the term *biotechnology* was primarily used in the food processing and agriculture industries. Then it began to be used by the Western scientific establishment to refer to laboratory-based techniques being developed in biological research, such as recombinant DNA or tissue culture-based processes, or horizontal gene transfer in living plants, using vectors such as the *Agrobacterium* bacteria to transfer DNA into a host organism. The term should be used in a much broader sense to describe the whole range of methods, both ancient and modern, used to manipulate organic materials to reach the demands of food production.

Biotechnology combines disciplines like genetics, molecular biology, biochemistry, embryology, and cell biology, which are in turn linked to practical disciplines like chemical engineering, information technology, and robotics.

Source links: <https://www.newworldencyclopedia.org/entry/Biochemistry>
<https://www.encyclopedia.com/people/science-and-technology/genetics-and-genetic-engineering-biographies/biotechnology>

2. Match the terms (1-18), transcriptions (a-r), and translations (i-xviii).

1) biocompatible	a) ['haɪbrɪdaɪ'zeɪf(ə)n]	i. патогенный/ болезнетворный
2) biopesticide	b) ['sɪmbɪ,ɒnt]	ii. биореактор
3) bioreactor	c) [mi:'θænə, trɒf]	iii. секвенирование
4) cytotoxicity	d) ['pæθə'dʒenɪk]	iv. цитотоксичность
5) gene therapy	e) ['baɪəʊrɪ, æktə]	v. имплантат
6) hybridization	f) [,faɪtəv'kemɪk(ə)l]	vi. ретровирус
7) implant	g) [,baɪəvʌkəm'pæɪtɪb(ə)l]	vii. симбионт
8) methanotroph	h) ['si:kwənsɪŋ]	viii. биопестицид
9) microscopy	i) [sɪ'leɪf(ə)n]	ix. репликация
10) pathogenic	j) [træns'dʒenɪk]	x. генотерапия
11) phytochemical	k) ['dʒi:n'θerəpɪ]	xi. тератогенность
12) replication	l) [tə,rætəvʌdʒə'nɪsɪtɪ]	xii. фитохимический
13) retrovirus	m) [,baɪəv'pestɪ,sɑɪd]	xiii. гибридизация
14) selection	n) [maɪ'krɒskəpɪ]	xiv. трансгенный
15) sequencing	o) [,saɪtəvʌk'sɪsɪtɪ]	xv. биологически совместимый
16) symbiont	p) [,replɪ'keɪf(ə)n]	xvi. метанотроф
17) teratogenicity	q) ['retrəv,vɑɪərəs]	xvii. селекция
18) transgenic	r) ['ɪmplɑ:nt]	xviii. микроскопия

3. For each definition (a-r) choose a suitable term from task 2.

- Able to cause disease.
- The interpretative application of microscope magnification to the study of materials that cannot be properly seen by the unaided eye.
- Anything surgically implanted in the body, such as a tissue graft or prosthesis.
- The degree to which an agent possesses a specific destructive action on certain cells or the possession of such action; the quality of being toxic to cells.

- e) Compounds that are used to manage agricultural pests through specific biological effects rather than as broader chemical pesticides.
- f) The act or process of producing hybrids that is an animal or plant resulting from a cross between genetically unlike individuals.
- g) Any organism that can use methane as a sole source of carbon and energy.
- h) The process whereby DNA makes a copy of itself before cell division.
- i) The science of methods for creating new varieties and breeds of organisms cultivated by humans with the necessary ("economically useful") attributes.
- j) Of an organism whose genome has been changed by the addition of a gene from another species; genetically modified.
- k) Determining the primary structure of an unbranched biopolymer, decoding of the genetic sequence.
- l) A class of RNA viruses that can produce double-stranded DNA copies of their genome that then integrate into the chromosome of the host cell.
- m) A fermentation vat, containing microorganisms or biochemically active substances, used for waste recycling or for making drugs.
- n) Relating to phytochemistry/chemical or nutrient derived from a plant source; a phytonutrient refers to a variety of plant-derived compounds with therapeutic activities such as anticarcinogenic, antimutagenic, anti-inflammatory, and antioxidant properties.
- o) An organism that is very closely associated with another, usually larger, organism.
- p) The ability or tendency to produce anomalies of formation.
- q) The introduction of new genes into cells to treat disease by restoring or adding gene expression.
- r) Compatible with biological tissue.

4. Complete the paragraphs using the terms studied in this unit (task 2). In some sentences the plural form is required. In each paragraph, the same word is missing.

- 1) In recent years the term ‘ _____ ’ has been used to distinguish plant chemicals that do not meet the classical definition of ‘essential nutrients.’ Some _____ produce activity in biological systems, including humans; hence, the term ‘bioactive _____.’ Liu (2013) has defined _____ as bioactive non-nutrient compounds in fruits, vegetables, grains, and other plant foods that have been linked to reductions in the risk of major noncommunicable chronic diseases.
- 2) _____ techniques are the election methods to characterize morphology of thin (two dimensional, 2D) samples or surfaces, comprising internal or fracture sections of 3D samples. The _____ techniques used for polymer biomaterials include light _____

(optical and stereo), scanning electron _____ (SEM), transmission electron _____ (TEM), and scanning probe _____, including atomic force _____ (AFM).

- 3) The _____ is the heart of any biochemical process in which enzymes, microbial, mammalian, or plant cell systems are used for the manufacture of a wide range of useful biological products. The main function of a properly designed _____ is to provide a controlled environment to achieve optimal growth and/or product formation in the particular cell system employed. To design a _____, some objectives have to be defined. The decisions made in the design of the _____ might have a significant impact on overall process performance. Knowledge of reaction kinetics is essential for an understanding of the working of a _____.
- 4) _____ has moved from a potential therapy at its inception in the late 1970s to clinically effective therapy in the second decade of the 21st century. Diseases for which there were no treatments available 40 years ago are now treated with _____ in experimental settings.
- 5) _____ play an important role in the oxidation of methane in the natural environment. They oxidize methane produced geothermally and by the anaerobic metabolism of methanogenic bacteria, thereby reducing the release of methane to the atmosphere from landfill sites, wetlands, and rice paddies.
- 6) _____ fungi are responsible for many diseases both in plants and animals and the identification of genes that are critical for growth or those that may be targeted by anti-fungal drugs is of extreme social and economical importance. Genome sequencing projects have been undertaken for several _____ and non-_____ fungi used as model organisms.
- 7) A major strength of the _____ α -synuclein models for PD is that expression alterations are not limited to dopaminergic neurons but are expressed throughout the nervous system. In addition, the slow accumulation of protein that occurs in _____ animals provides a better model of the progression seen in human disease.
- 8) DNA _____ is not initiated randomly throughout the genome, but at specific sites termed _____ origins. _____ origins are the sites where DNA _____ begins. Since most initiation events result in two _____ forks that travel in opposite directions, _____ origins are also termed “origins of bidirectional _____” (OBR). In bacteria, bacterial plasmids, bacteriophage, mitochondria, DNA animal viruses, and DNA plant viruses, the nucleotide sequence at the _____ origin is essential for DNA unwinding to begin.
- 9) _____ time is a significant challenge for an approach that adopts a sequential _____ and imaging approach to readout barcodes. This challenge arises from the observation that _____ of DNA oligonucleotides to cellular RNA is a slow process, typically requiring 6–24 h for efficient labeling because sequences on the cellular RNAs could be occluded by base-pairing with other sequences or by binding of proteins.

- 10) Titanium is a Group IV transition metal that has enjoyed great interest as one of the most important _____ metals, thanks to a suite of suitable biological and biomechanical properties. From a biological perspective, commercially pure titanium (CP Ti) has moderate to low cytotoxicity and is non-carcinogenic. Manufacturing by SLM process provided suitable mechanical properties in the health area, as well as, maintained the _____ properties of the Co-Cr-Mo alloy. _____ properties of Co-Cr alloys provided to these superalloys a wide range of applications in the health area.
- 11) Medical _____ are products that have to satisfy functionality demands defined by the working environment-human body. They could be used in almost every organ of the human body. Ideally, they should have biomechanical properties comparable to those of autogenous tissues without any adverse effects. The principal requirements of all medical _____ are corrosion resistance, biocompatibility, bio-adhesion, functionality, processability, and availability.
- 12) The most common _____ method is roulette wheel _____. The basic implementation of this method assigns each chromosome a “slice” of the wheel, with the size of the slice proportional to the fitness value of the chromosome. In other words, the fitter a member, the bigger slice of the wheel it gets. To select a chromosome for _____, the roulette wheel is “spun,” and the chromosome corresponding to the slice at the point where the wheel stops is grabbed as the one to survive in the offspring generation.
- 13) _____ is a manifestation of developmental toxicity, representing a particular case of embryo/fetotoxicity, by the induction or the increase of the frequency of structural disorders in the progeny. _____ of antiretrovirals has been of great concern since they first became available. _____ of these agents is being closely monitored by industry and the U.S. Food and Drug Administration.
- 14) Since the use of the _____ is markedly safer for the environment and users, and more sustainable than the application of chemicals, their use as alternatives to chemical pesticides, especially as components in Integrated Pest Management strategies, is of growing interest. Several _____ of the different classes have proved to be very effective in controlling potato pests.
- 15) The _____ is a very important aspect, as the destruction of healthy living cells around the wound will harm the healing process. _____ studies are a useful initial step in determining the potential toxicity of a test substance, including plant extracts or biologically active compounds isolated from plants.
- 16) The study of the enzymes and proteins encoded by _____ has defined fundamental mechanisms of cell transformation and other important paradigms of cell biology. Since the 1980s, _____ are demonstrated to cause many important human diseases, including lymphomas, leukemias, and AIDS.

- 17) RNA-Seq uses next-generation _____ technologies, such as SOLiD, 454, Illumina, or ION Torrent. The mRNA extracted from a sample is converted to cDNA using reverse transcription and sheared into fragments. Fragments within lengths of a certain range are selected and ligated with _____ adapters. This is usually followed by an amplification step after which one or both ends of the cDNA fragments are sequenced to produce either single or paired-end reads.
- 18) The term _____ has general meaning regardless of what system is being discussed. However, homology among many intracellular _____ extends to the compartment that encloses such bacteria. For example, similar membrane-bounded, bacteria-containing structures are found in legume nodules, amoeba endo_____, intracellular Legionella, malaria, etc.

5. Match two parts (1-13 and 1-13) of the terms, which consist of two or more words. Then match the compound terms, their transcriptions (a-m), and translations (a-m).

1) antibacterial	1. engineering	a) [ˈdɪfəˈrenʃ(ə)l ˈdaɪəɡˈnɒs-tɪk ɪnˈvaɪərənmənt]	a) клеточная инженерия
2) cell	2. medium	b) [ˈnju:triənt ˈmi:diəm]	b) генная инженерия
3) differential diagnostic	3. mutagenesis	c) [ˈdʒi:nəʊm ˈendʒɪˈniəriŋ]	c) зона ингибирования
4) genetic	4. medium	d) [feɪdʒ dɪsˈpleɪ]	d) геномная инженерия
5) genome	5. display	e) [ɪnˈdju:st ,mju:təˈdʒenɪsɪs]	e) молекулярная технология
6) induced	6. activity	f) [sɪˈlektɪv ˈmi:diəm]	f) питательная среда
7) inhibition	7. engineering	g) [ˌæntɪbækˈtɪ(ə)rɪəlækˈtɪvɪtɪ]	g) векторная ДНК
8) molecular	8. engineering	h) [ˈɪnhɪˈbɪʃ(ə)n ,zəʊn]	h) дифференциально-диагностическая среда
9) neural	9. environment	i) [ˈvektə ˈdi:ənˈeɪ]	i) избирательная среда
10) nutrient	10. prosthesis	j) [ˌsel ˈendʒɪˈniəriŋ]	j) индуцированный мутагенез
11) phage	11. zone	k) [məˈleɪkjʊlə tækˈnɒlədʒɪ]	k) антибактериальная активность
12) selective	12. DNA	l) [dʒɪˈnetɪk ˈendʒɪˈniəriŋ]	l) фаговый дисплей
13) vector	13. technology	m) [ˈnjuərəl prəsˈθɪsɪs]	m) нейропротез

6. For each definition (a-m) choose a suitable term from task 5.

- a) The complex of techniques for the production of new genes and the alteration of the structure of the chromosomes to produce effects beneficial to man, in agriculture and medicine.
- b) The manufacturing of products with a degree of precision defined by individual molecules or atoms.
- c) A special blend of nutrients used for species identification of microbes and study their properties.
- d) The capacity of a substance to kill or inhibit the growth of bacteria.
- e) A complex of methods for constructing cells with new properties, including methods of in vitro cultivation, cell hybridization, and genetic engineering, the basic approach is hybridization as a method for constructing new cells.
- f) A caused process by which the genetic information of an organism is changed, resulting in a mutation.
- g) An artificial device that replaces a missing body part lost through trauma, disease, or congenital conditions used to improve the function of an impaired nervous system.
- h) A technique for the production and screening of novel proteins and polypeptides by inserting a gene fragment into a gene responsible for the surface protein of a bacteriophage.
- i) Medium for culturing cells of one particular genotype and not suitable for cell growth of other genotypes.
- j) A virus or other agent used to deliver DNA to a cell.
- k) A medium providing or contributing to nourishment.
- l) A 2-step process that combines the ends-out (replacement) gene targeting with phage integrase ϕ C31-mediated DNA integration.
- m) A locally circumscribed place characterized by the reduction in rate or stopping of a chemical or biochemical reaction, due to interaction with a chemical agent.

7. Complete the following paragraphs with the terms studied task 5. In some sentences, the plural form is required. In each paragraph, the same word is missing.

- 1) People with central nervous system disorders suffer from an inability to communicate, move, and control their self-environment. Brain-computer/brain-machine interfaces and _____ have been designed to compensate for these frailties. Cochlear implants are devices in which the auditory nerves are stimulated through microelectrode arrays. At the interface of the neural tissue and neural electrodes, bioelectric signals are transduced to electrical signals by _____.
- 2) _____ is a well-established technique for identification, selection, and evolution of protein-ligand interactions widely used to address basic science questions, as well

as to develop top-notch technology in diverse fields ranging from research tools to personalized medicine and nanotechnology. The first reports describing _____ were published in the 1980s. Today scientists have at their disposal multiple in vivo and in vitro display techniques allowing sophisticated studies and manipulations of a broad range of protein-ligand interactions.

- 3) A new _____ was developed for monitoring populations of *Pseudomonas solanaceae* naturally and artificially infested soils. The basal medium was derived by modification of a standard triphenyl tetrazolium chloride medium. The final _____ is prepared by adding antimicrobial compounds.
- 4) The process of introducing a _____ into competent cells is called transformation. Bacteria can be used to grow large quantities of a single recombinant DNA molecule because they divide and grow exponentially, doubling in number every 30 min. When the host cell divides, the recombinant plasmids also replicate such that a high concentration of the desired DNA will be produced. Recombinant _____ are typically attenuated viruses or bacteria that are unrelated to the pathogen of interest. These _____ can penetrate human cells and often replicate within them, but do not cause disease in the host.
- 5) In general, the development and dissemination of validated protocols for _____, especially for less studied plant species, have not progressed apace with the enthusiastic use of mutation induction to create novel alterations in the genome. _____ has been proven to be a successful strategy for the improvement of several crops including rice.
- 6) With the growth of bacteria on _____ occurring chemical processes resulting from microbial cells of various enzymes. Some of them can break down proteins, others cause reactions of oxidation and reduction, and so on, through the action of enzymes in the differential diagnosis of the environment changes.
- 7) _____ is the most common type of antimicrobial activity reported for the acridone alkaloids, although a few cases of antifungal or antiviral activity have been reported.
- 8) _____ is a field that has progressed steadily over the last few decades, currently reaching a level of development that enables practical applications in human patients. By combining transurethral injection therapy principles with _____, which would allow for morphological and functional regeneration of the damaged urinary sphincter, injection of autologous chondrocytes promises to solve many problems currently faced by physicians who seek the ideal treatment for urinary incontinence through sphincter incompetence.
- 9) _____ is the manipulation of genetic material by either molecular biological techniques or by selective breeding. While selective breeding has been practiced for thousands of years (domestication of the dog; farming corn; brewer's yeast) the manipulation of genetic material in vitro was developed in the 1970s.

- 10) Several problems are associated with these diffusion methods comparing the relative antimicrobial activity of different compounds. The time taken for incubation may not allow testing for unstable antimicrobial agents. The _____ may only be compared among antimicrobial agents with similar physical properties such as diffusion rates in agar, volatility, or solubility in aqueous solution.
- 11) The _____ are widely used in everyday microbiological practice for the statement of laboratory diagnosis of infectious diseases, for selection of microbes of various subjects of the external environment to clarify the sources of infection, and when an epidemiological survey of people and animals to clarify the carriage of infectious diseases. P.F. apply also to obtain microbial mass used in the preparation of vaccines and diagnostic antigens in the production of antibiotics and others.
- 12) Recombineering-based _____ provides a powerful approach for constructing and modifying chromosomes synthetically. As the cost of oligonucleotide synthesis continues to drop and automation capacities continue to expand, efficient “on-the-fly” manipulation of a living organism’s genome will continue to improve.
- 13) _____ aims at selecting the best molecules and involves the global chain of designing, synthesizing, and organizing them into materials. It makes use of a combination of precision synthesis technologies, theoretical and computational science, and the manipulation of molecules.

8. Translate the sentences into Russian. The words in bold should be taken from the unit's list of terms.

- 1) The **antibacterial activity** of these organic acids is related to the concentration of the undissociated molecule, which probably penetrates better than the ionized form into the bacterial cell.
- 2) For the monitoring system to be effective, it must cast a broad net and cover major facilities such as petrochemical and **biopesticide** plants where chemical or biological warfare agents could be produced.
- 3) Bacterial devulcanization is carried out by mixing finely ground rubber with media containing the appropriate bacteria in a temperature-controlled **bioreactor**.
- 4) The most important toxicants of natural environments are plant toxins and animal venoms, and several plant toxins have been evaluated for **cytotoxicity**.
- 5) **Gene therapy** would not exist without animal models. Many biological concepts underlying **gene therapy**, and especially those using immunological tools, arise from animal studies.
- 6) Experimental and therapeutic interventions for **genetic engineering** raise special problems regarding free consent to medical or scientific experimentation.

- 7) The development of highly potent varieties by cross-breeding or **hybridization** is a specialized task and requires a knowledge of genetics to obtain strains with stable characteristics.
- 8) Medical **implants** and scaffolds for tissue engineering involve the use of composite coatings with various aims and objectives depending on the location and the purpose of the implants.
- 9) The increasing interest in **methanotrophic** bacteria especially in the context of climate change will likely lead to an increase in cultures available for in-depth studies.
- 10) Now since the new advancements in modern **molecular technologies**, we can sequence our genome in a very rapid time and at a very, very reduced cost.
- 11) Conducting polymers have been used for neural recording and stimulation of **neural prostheses** such as cochlear implants and deep brain stimulators.
- 12) Weather also can affect the survival and growth of **pathogenic** organisms through factors such as temperature change.
- 13) Using **phage display** with immune libraries offers several distinct advantages over hybridoma-based methods of monoclonal antibody generation.
- 14) Preclinical, clinical, and epidemiological research suggests that **phytochemicals** may be effective in treating various diseases owing to their antioxidant and anti-inflammatory activities.
- 15) Behavioral **teratogenicity** is not always expressed as a single type of adverse effect, but rather may be manifested as a continuum of effects, such as those exerted by ethanol.
- 16) Advanced **transgenic** methods to activate or perturb molecular mechanisms and to test the function of novel candidate genes under spatiotemporal control provide powerful means to address this complex biology.
- 17) Gene therapy using **DNA vector** technology is the most direct way to overexpress proapoptotic genes to kill cancer cells, but this would also be toxic to normal cells.

9. Put the parts in order to form a sentence.

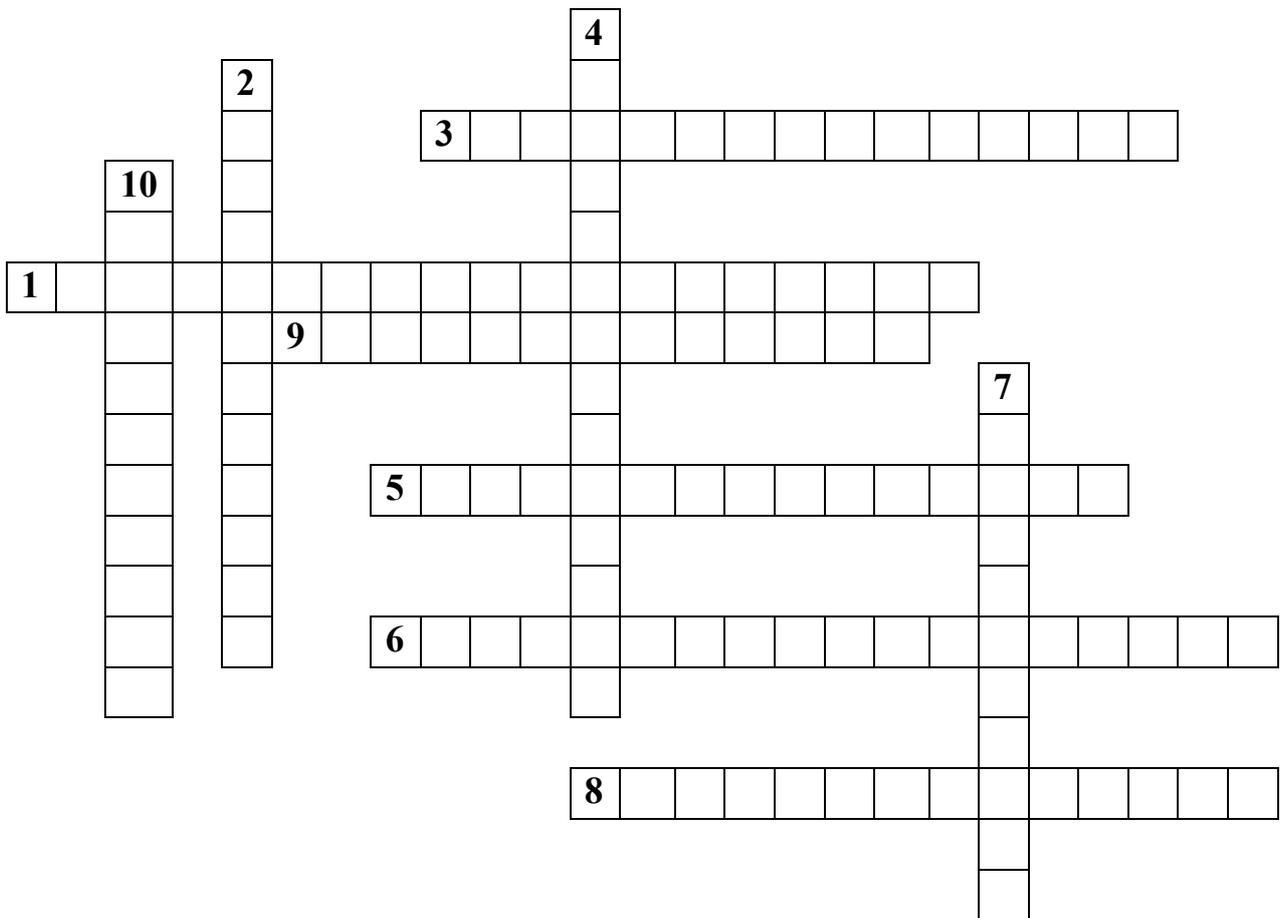
- 1) The limited/ the biopharmaceutical/ systems/ bioreactors/ protein/ capacity of/ industry/ expression/ has led/ to investigate/ alternative/ current/
- 2) Gene therapy/ information/ a phenotype/ purposes/ to modify/ uses/ for therapeutic/ the transfer of/ genetic/
- 3) There are/ conducting/ two types of/ can use/ when/ analysis:/ optical/ the analyst/ electron/ microscopy/ microscopy/ a fractographic/ and scanning/
- 4) Developments/ bacteria/ of information/ on the diversity/ and their potential/ in molecular technology/ gathering/ and bioinformatics/ of existing/ are facilitating/

- 5) Neural/ and applying/ electrical/ for monitoring/ signals/ tissue/ prostheses/ to neural/ are used/
- 6) Culturing/ transferring/ medium/ its propagules/ organism/ involves/ a soil/ conducive/ to growth/ to a nutrient/
- 7) An intriguing/ of dual-use/ hypothesis/ pathogenic/ the evolution/ fungi/ traits/ posits that/ became/ through/
- 8) Retroviruses/ equine/ cause/ cancers/ and certain/ in animals/ with slow/ anemia/ tumour/ growth/ and are associated/ infections/ such as/ infectious/ of animals,/
- 9) Less/ genetic/ techniques/ within/ are readily/ improvement/ selection/ breeds/ and crossbreeding/ such as/ and between/ controversial/ available,/

10. Solve a crossword puzzle using the terms of this unit.

- 1) The group of techniques used to cut up and join together genetic material, especially DNA from different biological species, and to introduce the resulting hybrid DNA into an organism to form new combinations of heritable genetic material.
- 2) An experimental treatment that is not just about replacing a missing or defective gene within patient's target cells but is also increasingly about supplementing the body with the production of proteins that can prevent or treat diseases as well, or the selective knockdown of genes whose expression is otherwise deleterious to good health.
- 3) A powerful group of chemicals that are derived from a natural resource, especially with plants origin.
- 4) A technique in which single-stranded nucleic acids are allowed to interact to form complexes or hybrids with sufficiently similar complementary sequences.
- 5) A manifestation of developmental toxicity, representing a particular case of embryo/fetotoxicity, by the induction or the increase of the frequency of structural disorders in the progeny.
- 6) The process of making targeted alterations in the genome of a living organism, that exploits the repair of a DNA double-strand break (DSB) through the endogenous pathway of homologous recombination (HR).
- 7) A vessel that carries out a biological reaction and is used to culture aerobic cells for conducting cellular or enzymatic immobilization.
- 8) A key group of environmental microorganisms that play an integral role in the global cycling of methane.
- 9) A molecular biology technique by which phage genomes are modified in such a way that the coat proteins of assembled virions are fused to other proteins or peptides of interest (of any origin), displaying them thus to the external milieu.

10) An RNA virus that replicates in a host cell through the process of reverse transcription.



11. Reading and summarizing information.

a) Read the text and choose the best title (1-5) for each paragraph (A-E).

- 1) Material hardening method
- 2) Innovation for bioelectronics
- 3) Breakthrough in synthetic biomaterials production
- 4) Reproducibility of body tissues
- 5) A new approach to the use of hydrogels

Materials scientists show way to make durable artificial tendons from improved hydrogels

Source link: <https://www.sciencedaily.com/releases/2021/02/210224120346.htm>

Date: February 24, 2021

Source: University of California - Los Angeles

(A) UCLA materials scientists and their colleagues have developed a new method to make synthetic biomaterials that mimic the internal structure, stretchiness, strength, and durability of tendons and other biological tissues.

The researchers developed a two-pronged process to enhance the strength of existing hydrogels that could be used to create artificial tendons, ligaments, the cartilage that are 10 times tougher than the natural tissues. Although the hydrogels contain mostly water with little solid content they are more durable than Kevlar and rubber, which are both 100% polymer. This kind of breakthrough has never been achieved in water-laden polymers until this study, which was recently published in *Nature*. The new hydrogels could also provide a coating for implanted or wearable medical devices to improve their fit, comfort, and long-term performance.

“This work shows a very promising pathway toward artificial biomaterials that are on par with, if not stronger than, natural biological tissues,” said study leader Ximin He, an assistant professor of materials science and engineering at the UCLA.

(B) Hydrogels are a broad class of materials with interior structures made up of criss-crossing polymers or gels. They show promise for use as replacement tissues, either to temporarily close wounds or as a long-term or even permanent solution. In addition, the gels may have applications for soft robots and wearable electronics.

However, current hydrogels are not strong or durable enough to mimic or replace tissues that need to move and flex repeatedly while bearing weight. To address these issues, the UCLA-led team employed a combination of molecular and structural engineering approaches that were not previously utilized together to make hydrogels.

(C) First, the researchers used a method called "freeze-casting" -- a solidifying process that results in porous and concentrated polymers, similar to a sponge. Second, they used a "salting-out" treatment to aggregate and crystallize polymer chains into strong fibrils. The resulting new hydrogels have a series of connecting structures across several different scales -- from molecular levels up to a few millimeters. The hierarchy of these multiple structures, similar to that of biological counterparts, enables the material to be stronger and more stretchable.

(D) As demonstrated by the team, this versatile method is highly customizable and could replicate various soft tissues in the human body.

The researchers used polyvinyl alcohol, a material already approved by the U.S. Food and Drug Administration, to make their hydrogel prototype. They tested its durability, seeing no signs of deterioration after 30,000 cycles of stretch testing. Under the light, the new hydrogel produced a vivid shimmer, similar to real tendons, confirming the micro/nanostructures that formed in the gel.

(E) In addition to biomedical applications, the advance may hold potential for surgical machines or bioelectronics that operate innumerable cycles, and 3D printing of previously unachievable configuration, thanks to the hydrogel's flexibility. The team demonstrated that such 3D-printed hydrogel architectures could transform into other shapes pending changes in temperature, acidity, or humidity. Acting as artificial muscles, they are much more resilient and could exert great force.

b) Answer the questions:

- 1) What is the main purpose of the work to improve the strength of hydrogels?
- 2) Which journals have published similar studies of hydrogels?
- 3) What approach did the team take to create the hydrogels?
- 4) What are the processes used to produce hydrogels?
- 5) What changes in hydrogels did the new method of obtaining give them greater strength?

c) Visit one of the websites <https://academic.oup.com/>, <http://abc-chemistry.org/>, <http://www-jmg.ch.cam.ac.uk/data/c2k/cj/> or any other website publishing research articles in Chemistry, choose an article, read and summarize its content using the plan and useful phrases in the Appendix. The length of the summary should be about 10 % of the original text.

Unit 11. Pharmacy and Pharmacology

1. Read the text and say what is the difference between pharmacy and pharmacology? Which of the fields is more vital in your opinion? Why?

Pharmacy is the art and science concerned with the preparation and standardization of drugs. Among the tasks of this field of research are recognizing, identifying, collecting, selecting, preparing, storing, testing, compounding, and dispensing all substances used in preventive or curative medicine. Its scope includes the cultivation of plants that are used as drugs, the synthesis of chemical compounds of medicinal value, and the analysis of medicinal agents. Pharmacists are responsible for the preparation of the dosage forms of drugs, such as tablets, capsules, and sterile solutions for injection. The science that embraces knowledge of drugs with special reference to the mechanism of their action in the treatment of disease is **pharmacology**.

Though nowadays most drugs are prepared by pharmaceutical manufactures and are distributed to the chemist's or hospital in such suitable dosage forms as tablets, capsules, liquid preparations, or sterile solutions for injection, the pharmacist now has no less a responsible role in properly dispensing the preparation in finished forms than when he powdered, dissolved, mixed, and otherwise compounded prescriptions. Compounding and dispensing medicines demand special knowledge, experience, and high professional standards. To become a pharmacist, one must achieve knowledge of different subjects, such as physics, chemistry, biology, pharmacology, toxicology, pharmacognosy, the technology of drugs, organization and economy of pharmacy, management, and marketing in pharmacy.

When supplying both prescription and over-the-counter (OTC) medication to patients, the pharmacist also provides information required for the safe and effective use of such drugs. The pharmacist further serves as an information source of all aspects of drugs to his colleagues in the medical, dental, and nursing professions.

These advisory roles are made possible by the vast background of the pharmacist, the drug expert, in fields such as pharmacognosy, pharmacology, medicinal chemistry, and pharmaceuticals. The pharmacist needs to know where the dosage form can be obtained; if the drug is readily absorbed; if it has stability; and if there is anything in the literature to confirm the reliability of this dosage form for a particular patient. The pharmacist must also know what tablets can be crushed and added to food (or used in compounding) without altering the drug's effectiveness and dose regimen.

Pharmacology is a branch of medicine that deals with the interaction of drugs with the systems and processes of living animals, in particular, the mechanisms of drug

action as well as the therapeutic and other uses of the drug. It is the science of drugs and their effect on living systems.

Every medication we take alters the chemistry within our bodies. The role of pharmacology is to understand why these changes are happening, allowing us to develop better drugs. Pharmacology is crucial for:

- discovering new medicines to help fight diseases
- improving the effectiveness of medicines
- reducing unwanted side effects of medicines
- understanding why individuals differ in the way they respond to certain drugs, and why some others cause addiction

Pharmacology lies at the heart of biomedical science, linking together chemistry, physiology, and pathology. Pharmacologists work closely with a wide variety of other disciplines that make up modern biomedical science, including neuroscience, molecular and cell biology, immunology, and cancer biology. Pharmacological knowledge improves the lives of millions of people across the world. It maximizes their benefit and minimizes risk and harm. As new diseases emerge, and older medicines - like antibiotics - no longer work as well, the contribution of pharmacology to finding better and safer medicines becomes all the more vital.

Source links: <https://infopedia.su/7x1a75.html>

<https://www.britannica.com/science/pharmacy>

<https://www.britannica.com/science/pharmacology>

<https://www.bps.ac.uk/about/about-pharmacology/what-is-pharmacology>

2. Match the terms (1-18), transcriptions (a-r), and translations (i-xviii).

1) alfacalcidol	a) [ˈɪnsjʊlɪn]	i. биоподобный препарат, биосимиляр
2) antibiotic	b) [ˌfɑ:məkəʊdaɪˈnæmɪks]	ii. лидокаин
3) antidepressant	c) [ˈælfəˌkælsɪˈdɒl]	iii. инсулин
4) biosimilar	d) [ɔˈmeɪprəzɔːl]	iv. тиамин; витамин B1
5) immunobiological (medicinal product)	e) [ˌli:vʊsɪˈmendən]	v. альфакальцидол
6) insulin	f) [ˈɔɪntmənt]	vi. мазь
7) levosimendan	g) [ˌfɑ:məkəʊkɪˈnetɪks]	vii. антибиотик
8) lidocaine	h) [ˈmɪldrəˌneɪt]	viii. ретинол; витамин A
9) mildronate	i) [ˈæntɪbaɪˈɔtɪk]	ix. мельдоний
10) ointment	j) [ˌfɒsfəˈlɪpɪd]	x. фармакокинетика
11) omeprazole	k) [ˌɪmjʊnə(u)ˌbaɪ-əˈləʤɪk(ə)l]	xi. антидепрессант
12) pharmacodynamics	l) [ˈbaɪəʊˈsɪmɪlə]	xii. радиофармацевтический препарат
13) pharmacokinetics	m) [ˈθaɪəmɪn]	xiii. иммунобиологический лекарственный препарат
14) phospholipid	n) [ˈæntɪdɪˈpres(ə)nt]	xiv. фармакодинамика
15) pyridoxine	o) [ˌreɪdɪəʊˌfɑ:məˈsʊtɪkəl]	xv. Левосимендан
16) radiopharmaceutical	p) [ˈretɪˌnɒl]	xvi. пиридоксин; витамин B6
17) retinol	q) [ˈlaɪdəˌkeɪn]	xvii. омепразол
18) thiamine	r) [ˌpɪrɪˈdɒksɪːn]	xviii. фосфолипид

3. For each definition (a-r) choose a suitable term from task 2 (1-18).

- a) Medicinal product of biological origin designed for the immunological diagnostics, prevention, and treatment of various diseases.
- b) The quantitative study of the relationship between drug exposure (concentrations or dose) and pharmacologic or toxicologic responses.
- c) A water-soluble sulfur-containing vitamin, one of the constituents of vitamin B complex, found in meat, yeast, and bran, that is necessary for the metabolism of carbohydrates.
- d) A class of drugs used for the treatment of depression and other conditions including anxiety disorders, obsessive-compulsive disorder, eating disorders, chronic pain, neuropathic pain and, in some cases, dysmenorrhea, snoring, migraines, attention-deficit hyperactivity disorder, substance abuse, and sleep disorders; a generic term used to refer to drug classes such as tricyclic antidepressants (TCAs), selective serotonin reuptake inhibitors (SSRIs), and serotonin-norepinephrine reuptake inhibitors (SNRIs).
- e) A synthetic vitamin D compound used for supplementation in humans and as a poultry feed additive.
- f) A local anesthetic and cardiac depressant used as an antiarrhythmic agent used topically on the skin and mucous membranes.
- g) Any member of a large class of fatlike, phosphorus-containing substances that play important structural and metabolic roles in living cells.
- h) A chemical substance, produced by microorganisms and synthetically, that can inhibit the growth of, and even destroy, bacteria and other microorganisms.
- i) A pancreatic hormone that regulates blood glucose levels by stimulating the conversion of glucose to glycogen.
- j) A semisolid preparation usually containing medicinal substances and intended for external application.
- k) A reproduced biological medicinal product declared as similar in quality, safety, and efficacy to a previously registered, reference, innovative medicinal product and having a similar international name.
- l) A calcium-sensitizing drug that exerts positive inotropic effects by sensitization of myofilaments to calcium and vasodilation through an opening of ATP-dependent potassium channels on vascular smooth muscle.
- m) A butyrobetaine analog that is known to inhibit gamma-butyrobetaine hydroxylase, the enzyme catalyzing the last step of carnitine biosynthesis.
- n) A branch of pharmacology that describes the processes of absorption, distribution, metabolism, and excretion of a drug by the body as a mathematical function of time and concentration.

- o) A derivative of pyridine, water-soluble vitamin that is part of the B vitamin group, an essential nutrient required for the normal functioning of many biological systems within the body that is naturally present in many foods.
- p) The first of a new class of drugs, the proton pump inhibitors (PPIs), that control acid in the stomach, and elucidation of its mechanism of action was a major achievement.
- q) Biologically active molecules labeled by radionuclides which provide a beneficial source of ionizing radiation mainly applied in diagnostic imaging and therapy.
- r) A fat-soluble carotenoid vitamin (vitamin A), present in fish oils and green vegetables, essential to normal vision and bone development.

4. Complete the paragraphs using the terms studied in task 2. In some sentences, the plural form is needed.

- 1) The nutritional effects of vitamin A (_____) and its role in controlling various physiological functions in mammalian cells are well-known.
- 2) Administration of _____ to a human results in the acquisition of active (vaccines, toxoids) or passive (normal and specific human immunoglobulins) immunity, _____ also include some other medicinal products of biological origin (bacteriophages, probiotics, cytokines, including interferons, allergens, and allergoids, microbial enzymes), as well as medicinal products obtained by biotechnological processes, including genetic engineering techniques.
- 3) _____, the most widely studied calcium sensitizer, increases myocardial contractility by increasing myofilament sensitivity to calcium. _____ is also a potent vasodilator due to activation of adenosine triphosphate-dependent potassium channels in vascular smooth muscle cells, leading to decreases in both preload and afterload.
- 4) Patients with bipolar disorder often suffer from depression, which makes balancing benefits and harms of _____ medication difficult. Some findings suggest that tricyclic _____ should not be used in depressed patients with bipolar disorder unless it is essential and that serotonin and noradrenaline reuptake inhibitors should probably be first-line treatment.
- 5) _____ has a weaker impact on calcium metabolism than calcitriol while having more potent effects on parathyroid hormone levels and the immune system, including regulatory T cells. It is considered to be a more useful form of vitamin D supplementation, mostly due to a much longer half-life and lower kidney load. Used as a poultry feed additive, it prevents tibial dyschondroplasia and increases phytate bioavailability.
- 6) The _____ system consists of _____ originating from the pancreas and ubiquitously expressed _____ receptors throughout the body. _____ is transported via the plasma

throughout the body including the brain. Peripherally, _____ provides a conduit for glucose sequestration into cells.

- 7) _____ is defined as the response of the body to the drug. It refers to the relationship between drug concentration at the site of action and any effects, namely, the intensity and time course of the effect and adverse effects. _____ is affected by receptor binding and sensitivity, post-receptor effects, and chemical interactions.
- 8) Vitamin B1, also known as _____, is a water-soluble vitamin found in several sources, both animals and vegetables. Deficiency or low levels of _____ could produce diverse diseases named “_____ Deficiency Syndrome” such as beriberi and inflammation of nerves (neuritis) associated with pellagra or pregnancy.
- 9) _____ is the most commonly used local anesthetic in the operating room. It is the prototype amide local anesthetic. _____ is absorbed rapidly after parenteral administration and from the gastrointestinal and respiratory tracts. _____ is metabolized in the liver, and it has active metabolites. The toxic side effects of _____ occur with increasing concentrations of the drug in the blood: patients will experience drowsiness, tinnitus, dysgeusia, dizziness, and muscle twitching.
- 10) _____ are useful in moderate to severe exacerbations of chronic obstructive pulmonary disease. However, there remains considerable controversy as to _____ choice, especially for initial empiric therapy of exacerbations. Results of _____ comparison trials should guide the recommendations for appropriate empiric _____ in exacerbations.
- 11) _____ (better known as meldonium) has recently drawn a lot of attention after the suspension of a high-profile tennis player for doping. _____ indirectly acts as a pFOX inhibitor by blocking the enzyme γ -butyrobetaine hydroxylase, which catalyzes the biosynthesis of carnitine. Carnitine is essential for the transfer of long-chain fatty acids across the mitochondrial inner membrane for oxidation and ATP synthesis.
- 12) _____ are amphiphilic molecules with hydrophobic fatty acid chains and hydrophilic moieties. They occur naturally in all living organisms as the major components of cell membranes. Various _____ classes with different polar moieties are found in nature. pH greatly affects the association of the polar moieties in _____. When dispersed in water, _____ hydrate forming lamellar or hexagonal phases, a behavior which is related to the functions of cell membranes. Due to their amphiphilic nature, _____ are often used as emulsifiers. Being easily oxidized due to the presence of unsaturated fatty acids, _____ also exhibit antioxidative activities. _____ are beneficial for human health. They are currently produced in the form of lecithin.
- 13) A _____ is a copy of a biological molecule that claims to be similar to an innovative biological protein therapeutic product (reference product) that is already approved

and marketed. The approaching expiry of patents on various innovative biological products, combined with the enactment of legislation for the approval of _____ products in major regions, has led to a substantial increase in the pharmaceutical industry's interest in developing _____ products.

- 14) _____ is a proton pump inhibitor that inhibits secretion of gastric acid by irreversibly blocking the enzyme system of hydrogen/potassium adenosine triphosphatase, the "proton pump" of the gastric parietal cell. The drug is used in conditions, where the inhibition of gastric acid secretion may be beneficial, including aspiration syndromes, dyspepsia, gastro-oesophageal reflux disease, peptic ulcer disease, and the Zollinger–Ellison syndrome. The dose of _____ may need to be reduced in patients with hepatic impairment.
- 15) _____ deals with the time course of a drug in the body from administration to its elimination. _____ principles are used to describe drug absorption, distribution, metabolism, and excretion. Using _____ principles we can establish an association between drug exposure in an easily accessible biological sample such as blood/plasma and the pharmacological effect of the drug.
- 16) _____ is important in cerebral metabolism. If infants are given a diet deficient in _____, a small proportion of them will develop symptoms of growth retardation, anemia, and convulsions. These symptoms will respond to the administration of a few milligrams of _____ per day. If _____ deficiency is not corrected, the cerebral damage becomes permanent, and the infant may have recurrent convulsions that are unresponsive to _____.
- 17) _____ are greasy and thicker than creams. Some are both lipophilic and hydrophilic, i.e. by occlusion they promote dermal hydration but are also water-miscible. Other _____ bases are composed largely of lipid; by preventing water loss they have a hydrating effect on skin and are used in chronic dry conditions. _____ contain fewer preservatives and are less likely to sensitize.
- 18) Many different _____ have been approved for use in clinical nuclear medicine studies. Each of these _____ is targeted to measuring a specific biologic process, and therefore what is measured depends directly on which _____ is administered to the patient. Most _____ are used in conjunction with imaging systems that can determine the location of the _____ within the body. Often, the rate of change of _____ localization within a specific tissue (the rate of uptake or clearance) is important and is measured by acquiring multiple images as a function of time.

5. Match two parts (1-12 and 1-12) of the terms, which consist of two or more words. Then match the compound terms, their transcriptions (a-l), and translations (i-xii).

1) antibacterial	1. form	a) [ˈhɒmiəˈpæθɪkˈmedɪs(ə)n]	i. антигистамин
2) auxiliary	2. antagonist /antihistamine	b) [baɪəˈlɒdʒɪkˈdrʌɡ]	ii. орфанный препарат; лекарственное средство для редких показаний
3) biologic	3. medicine	c) [ˈdrʌɡɪkˈskriːf(ə)n]	iii. бактерицидное/антибактериальное средство
4) dosage	4. drug	d) [ˌθerəˈpjuːtɪkɪˈkwɪvələns]	iv. воспроизведённый препарат
5) drug	5. substance	e) [dʒɪˈnerɪkˈdrʌɡ]	v. вспомогательное вещество
6) generic	6. drug	f) [ˈɔːfənˈdrʌɡ]	vi. дозированная лекарственная форма
7) histamine	7. drug	g) [ˈæntɪbækˈtɪəriəlˈeɪdʒ(ə)nt]	vii. психотропный препарат
8) homeopathic	8. excretion	h) [ˈhɪstəmiænˈtægənɪst /ˌæntɪˈhɪstəmɪn]	viii. выведение препарата из организма
9) medicinal	9. equivalence	i) [ɔːgˈzɪljəriˈsɒbstəns]	ix. лекарственное растение
10) orphan	10. plant	j) [ˌsaɪkəˈtrəʊpɪkˈdrʌɡ]	x. терапевтическая эквивалентность
11) psychotropic	11. agent	k) [ˈdəʊsɪdʒˈfɔːm]	xi. биологический препарат
12) therapeutic	12. drug	l) [məˈdɪsən(ə)lˈplɑːnt]	xii. гомеопатический препарат

6. For each definition (a-l) choose a suitable term from task 5.

- A drug that has the same pharmacological effects and actions in the treatment of illnesses as another drug even though the drugs may not be chemically equivalent.
- A chemical substance that changes brain function and results in alterations in perception, mood, consciousness, cognition, or behavior.
- Highly diluted preparations of substances, whose effects, when administered to healthy subjects, correspond to manifestations of the disorder (symptoms, clinical signs, and pathologic states).

- d) Pharmaceutical drug products in the form in which they are marketed for use, with a specific mixture of active ingredients and inactive components (excipients), in a particular configuration (such as a capsule shell, for example), and apportioned into a particular dose.
- e) A substance that has the properties of destroying or inhibiting the growth or reproduction of bacteria.
- f) A drug product that is comparable to brand/reference listed drug product in dosage form, strength, route of administration, quality and performance characteristics, and intended use.
- g) Inorganic or organic substances used in the production/manufacture of drugs to give them the necessary physicochemical properties.
- h) A medicinal drug that is effective in the treatment of some disease(s), but which is not manufactured or marketed because the demand is insufficient to cover the costs of supply.
- i) The richest bioresource of drugs of traditional systems of medicine, modern medicines, nutraceuticals, food supplements, folk medicines, pharmaceutical intermediates, and chemical entities for synthetic drugs.
- j) A heterogeneous group of compounds, with markedly differing chemical structures, a spectrum of antihistaminic properties, half-lives, tissue distribution, and metabolism, and varying degrees of anti-inflammatory effects, used to treat allergies and hypersensitive reactions and colds; works by counteracting the effects of histamine on a receptor site.
- k) The removal of drugs from the body, either as a metabolite or unchanged drug.
- l) A group of medical products made from living organisms or contain components of living organisms, including vaccines, blood products, allergens, somatic cells, tissues, recombinant proteins.

7. Complete the following paragraphs using the terms studied in task 5. In some sentences, the plural form is required. In each paragraph, the same word is missing.

- 1) A _____ is a drug defined as “a drug product that is comparable to brand/reference listed drug product in dosage form, strength, route of administration, quality and performance characteristics, and intended use.” It has also been defined as a term referring to any drug marketed under its chemical name without advertising.
- 2) The use of _____ has spread more and more with the worldwide increase in the use of _____ and the rapid expansion of the global market, the safety and the quality of _____ has become a major concern. The safety of the _____ largely depends on their quality. Requirements and methods for the quality control of finished

_____ are far more complex than for chemical drugs, particularly for the combined or mixed _____.

- 3) Legislation aside, due to the vagaries of European healthcare systems, approval is not the only hurdle for _____. A study of the first five EMEA-approved _____ found much variability across EU countries with regard to availability, market availability delays, and prices. The number of _____ available seems to be correlated to the mean _____ prices, with countries with more _____ available also having lower prices.
- 4) _____ include a wide variety of products derived from human, animal, or microorganisms by using biotechnology. Types of _____ include vaccines, blood, blood components, cells, allergens, genes, tissues, and recombinant proteins.
- 5) The concept of _____, as used to develop the list of products in the Orange Book, applies only to drug products containing the same active ingredient(s) and does not encompass a comparison of different therapeutic agents used for the same condition.
- 6) _____ are prescribed to treat a variety of mental health issues when those issues cause significant impairment to healthy functioning. _____ typically work by changing or balancing the amount of important chemicals in the brain called neurotransmitters. _____ are usually prescribed by a psychiatrist, a psychiatric nurse practitioner, or a primary care physician.
- 7) _____ are used worldwide as an alternative and/or complementary medicine. Studies on these _____ including pharmacological and toxicological evaluations are essential for drug research and development. The main types of toxicological evaluations include acute toxicity, subacute toxicity, subchronic toxicity, and chronic toxicity studies. _____ also can be poisonous, affecting the entire spectrum of organ systems, with some plants containing several toxic principles that affect different systems.
- 8) Most topical _____ have a rapid onset of action, but have a short duration of action, requiring up to four times daily dosing. Selective _____ with mast cell stabilizing properties have been shown to have a rapid onset but a longer duration of action when compared to the other topical _____, lasting up to 16 hours.
- 9) The invention relates to medicine and concerns a combined medicinal preparation that has anti-tuberculosis activity and is in a solid dosage form which contains, as the active principle, a combination of p-aminosalicylic acid and a zinc-containing compound and pharmaceutically acceptable _____. API mixtures manufactured as e.g. beadlets, granulates, or within a spray drying process are physically processed. Physical processing can involve _____ (e.g. coating agent) and therefore such API mixtures fall under the definition of an API.
- 10) _____ is the process of eliminating a drug from the body. A drug, which is either biologically active itself or a prodrug, may be excreted in its original chemical state.

Alternatively, all or a portion of a drug may undergo chemical modification and be eliminated as biologically active, or inactive, metabolites.

- 11) _____ indicated for clinical use are agents that selectively destroy bacteria by interfering with bacterial growth or survival. Among existing _____, antibiotics may be informally defined as compounds that are produced by living organisms, are derived from bacterial, fungal, mold, plant, and animal sources, and are used to treat bacterial infections.
- 12) Novel pharmaceutical _____ cover a broad range of formulation delivery platforms such as tablets, capsules, cachets, sustained-release _____, parenteral _____, transdermal _____, metered-dose inhalants, solutions, emulsions, and suspension. Though there are several analytical techniques (i.e., chromatographic, titrimetric, gravimetric, etc.) and manual (i.e., grinding, shaking, sonication, centrifugation, etc.) or automated robotic (i.e., homogenizers) sample preparation procedures available for pharmaceutical _____ analysis, the nature of the _____ dictates the kind of analytical technique and sample preparation procedure(s) to employ.

8. Translate the sentences into English. Pay attention to the terms from the unit's list.

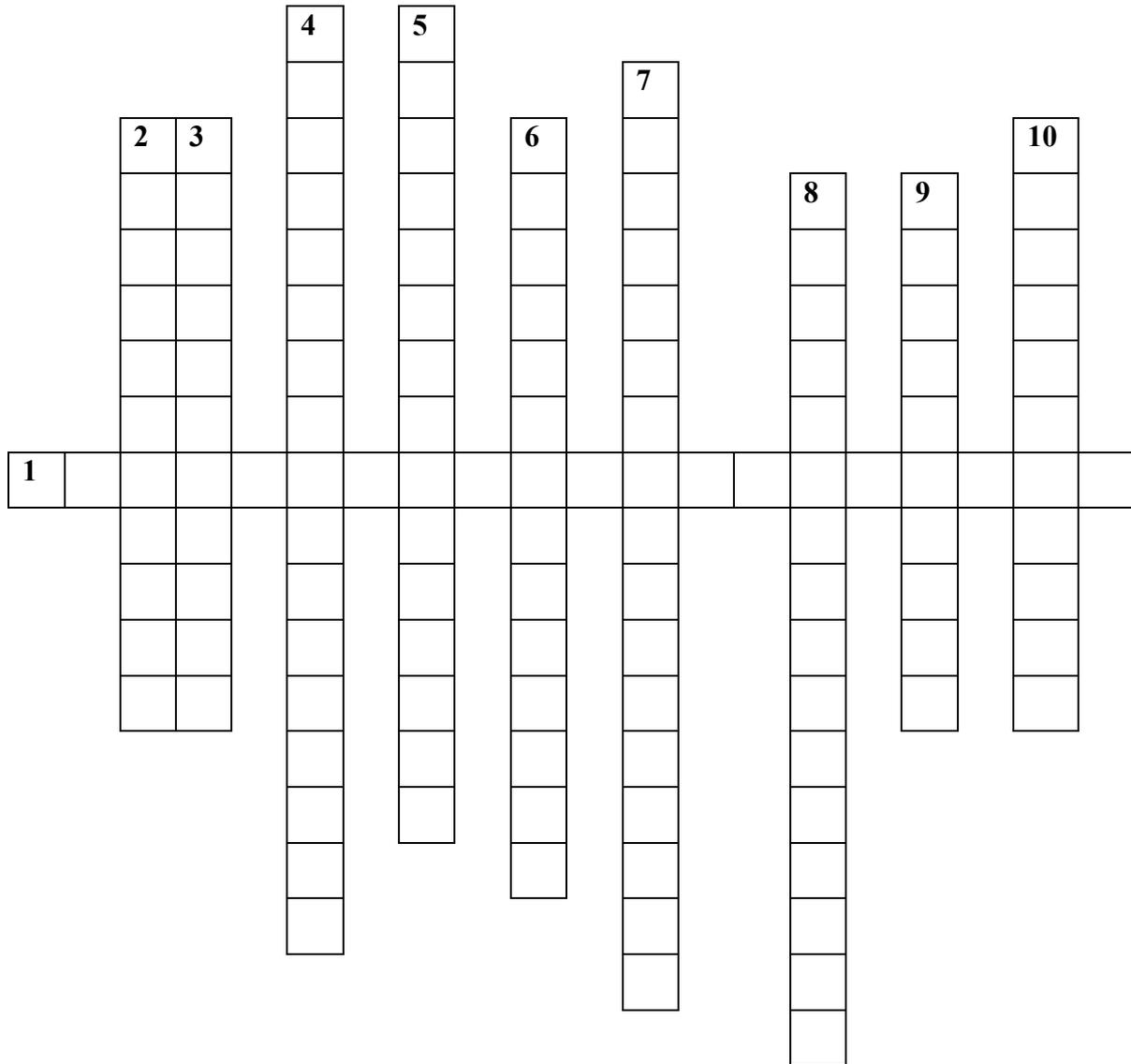
- 1) **Альфакальцидол** обладает примерно в два раза большей способностью связываться с природными рецепторами кальцитриола, чем эргокальциферол.
- 2) Анестезиологи часто назначают антибиотикопрфилактику хирургическим пациентам и должны быть хорошо осведомлены о показаниях, дозировках, осложнениях и взаимодействии **антибиотиков** с анестетиками и другими лекарственными препаратами, используемыми в периоперационном периоде.
- 3) Хотя **антидепрессантные** соединения использовались у пациентов, страдающих различными болезненными состояниями с момента их первого выпуска почти 50 лет назад, их использование в этой клинической ситуации было основано на логическом представлении о том, что большинство пациентов с неутоленной болью были подавлены.
- 4) В отличие от классических препаратов, которые представляют собой малые молекулы, **биологические препараты** в большинстве случаев представляют собой белки или нуклеиновые кислоты, и их преимущество перед классическими препаратами заключается в их целенаправленном действии.
- 5) Основной целью **биоаналогов** является снижение затрат на здравоохранение, связанных с использованием **биологических препаратов**, и тем самым расширение доступа к медицинскому обслуживанию.

- 6) Фармацевтические **лекарственные формы** представляют собой систему доставки, смешанную с активным веществом и рядом ингредиентов для облегчения простоты введения и изготовления.
- 7) Производство **иммунобиологических препаратов** предполагает сложный и многоотраслевой технологический процесс (например, культивирование штаммов микроорганизмов и эукариотических клеток, извлечение веществ из биологических тканей и крови человека и животных, использование технологии рекомбинантных ДНК, гибридной технологии и др.).
- 8) **Инсулин** играет важную роль не только в углеводном обмене, но и в анаболической регуляции белков и липидов, соматическом росте и пролиферации клеток в процессе развития.
- 9) В клинической практике **левосимендан** продемонстрировал способность увеличивать ударный объем и сердечный выброс, одновременно снижая легочное сосудистое сопротивление, клин легочных капилляров, уровень СВР и натрийуретического пептида, что может уменьшить симптомы сердечной недостаточности.
- 10) **Лидокаин** вероятно наиболее обыкновенно используемый местный анестетик в клинической практике из-за своей мощи, быстрого натиска, умеренной продолжительности действия, и злободневной анестетической деятельности.
- 11) Химическое развитие **омепразола** было осложнено плохой стабильностью и чувствительностью соединения к свету, что требовало особых мер предосторожности при составлении препарата.
- 12) Межиндивидуальная вариабельность **фармакодинамики** может быть генетической или отражать развитие толерантности к препарату при длительном воздействии.
- 13) **Пиридоксин**, принимаемый в больших дозах, может вызвать сенсорную невропатию с парестезиями, диффузной сенсорной потерей, сенсорной атаксией и вегетативной дисфункцией.
- 14) Большинство **радиофармпрепаратов** представляют собой комбинацию радиоактивной молекулы, радионуклида, который позволяет внешнее обнаружение, и биологически активной молекулы или лекарственного средства, которое действует как носитель и определяет локализацию и биораспределение.
- 15) Изучение абсорбции лекарственных средств имеет решающее значение для разработки новых лекарственных средств и установления **терапевтической эквивалентности** новых рецептур или генерических версий существующих лекарственных средств.

9. Put the parts in order to form a sentence.

- 1) **Antibacterial**/ that fight/ materials/ against/ pathogenic/ a group of/ agents/ bacteria/ are/
- 2) **Antibiotics**/ with/ adjuvants/ side effects/ anesthetic/ interact/ possess/ and/ spectrum of/ a diverse/ a number of/
- 3) **Antidepressant**/ to maintain/ activities/ occupational/ are usually/ people/ drugs/ usual/ who/ are trying/ their/ and social/ taken by/
- 4) The capsule/ substances:/ also/ disintegrating/ and, optionally,/ contains/ a physiological/ and antifriction/ neutral filler/ **agents**/ matter/ **auxiliary**/
- 5) In cancer/ are the most/ **biological**/ antibodies/ used/ the monoclonal/ therapy/ **drugs**/ frequently/
- 6) Most/ medicines/ **medicine**/substance/ in material/ none of/ are so dilute/ that/ in the potentized/ medicinal/ is contained/ form/ the original/ **homeopathic**/
- 7) **Insulin**/ in the body/ glucose/ is essential/ cells/ as it allows/ to take up/ metabolize/ and then/
- 8) After/ application/ crosses/ the blood/ circulation/ and reaches/ system/ the drug/ molecule/ several /skin layers/ on skin,/ **ointment**/
- 9) **Pharmacodynamic**/ are changed/ of another/ in the presence/ the actions of/ are where/ one drug/ interactions/
- 10) Low/ organic/ solvents/ are often/ high polarity/ ethanol,/ such as/ and ethyl acetate/ edible/ extraction/ or non-toxic/ **phospholipid**/ of relatively/ acetone/ used for/
- 11) **Psychotropic**/ changes/ are an example/ for the management/ in brain/ wherein/ of psychiatric/ the various/ are beneficial/ disorders/ **drugs**/
- 12) **Retinol**/ compound/ is a chemically/ unstable/ medium/ and quite/ in the aqueous/ insoluble/

10. Solve a crossword puzzle using the terms of this unit.



- 1) Unusual chemicals, many of which are potentially dangerous (for example, lung pus), distilled to a level where the original ingredient is no longer discernible on most laboratory tests.
- 2) An essential cofactor in the metabolism of proteins, carbohydrates, fatty acids, and brain amines.
- 3) A “follow-on” or copy version of an innovator biologic therapeutic product (e.g. monoclonal antibodies, recombinant proteins, fusion proteins) that has already been approved by a regulatory authority and marketed.
- 4) The study of the relationship between the concentration of drug at the site of action and the biochemical and physiological effect.
- 5) The plants that possess therapeutic properties or exert a beneficial pharmacological effect on the human or animal body.

- 6) Amphiphilic lipids consisting of a glycerol backbone or an amino-alcohol sphingosine backbone, which is esterified to one or two fatty acids, a phosphate group, and a hydrophilic residue.
- 7) The study and mathematical description of the relationship between the dose of a drug and its concentration in body fluids and tissues over time.
- 8) Psychotropic drugs for the treatment of depressive syndromes of various etiology.
- 9) An aminoethylamide that is superior to procaine in its speed to onset, intensity, extensiveness, and duration of effect that is used in a patch formulation for the treatment of the pain associated with postherpetic neuralgia and is also used as an anti-arrhythmic agent.
- 10) A drug with high therapeutic interest and scientific viability that is not available due to different reasons or circumstances to treat or ameliorate the health problems of a patient.

11. Reading and summarizing information.

a) Read the text and choose the best title (A-H) for each paragraph (1-7). There is one title that you do not need to use.

- A. What makes FR such a good inhibitor
- B. The FR molecule effectively inhibits Gq proteins
- C. Bacteria in the leaves produce FR
- D. New achievements
- E. Prospects for further study of the molecule
- F. A soil relative
- G. Valuable properties of coral berries
- H. Genetically modified bacteria

Bacterium produces pharmaceutical all-purpose weapon.

Study should significantly facilitate research into the promising substance

Source link: <https://www.sciencedaily.com/releases/2021/01/210111115747.htm>

Date: January 11, 2021

Source: University of Bonn

(1) For some years, an active substance from the leaves of an ornamental plant has been regarded as a possible forerunner of a new group of potent drugs. So far, however, it has been very laborious to manufacture it in large quantities. That could now change. Researchers at the University of Bonn (Germany) have identified a bacterium that produces the substance and can also be easily cultivated in the laboratory. The results are published in the journal *Nature Communications*.

(2) The coralberry currently once again adorns many living rooms. In winter it bears bright red fruits, which make it a popular ornamental plant. For pharmacists, however, it is interesting for a different reason. It contains an active substance that can be used against asthma and certain types of cancer.

(3) Unfortunately, obtaining the substance with the cryptic name FR900359 (abbreviated: FR) in larger quantities is rather laborious. Cultivating the plants in greenhouses takes many weeks; moreover, the yield can vary enormously depending on the specimen. Incidentally, they do not produce the active ingredient themselves but have bacteria in their leaves that do it for them. "However, these only grow in the coralberry and cannot be cultivated in the laboratory," explains Dr. Max Crüsemann of the Institute of Pharmaceutical Biology at the University of Bonn.

(4) Manufacturing FR is a complex undertaking. The bacteria have a special assembly line for this purpose, in which a number of enzymes work hand in hand. The bacterial genetic makeup specifies how this assembly line must be set up. The researchers searched for other microorganisms that also have these genes for FR synthesis and came across another bacterium. Unlike its coralberry relative, it grows in soil and is easily propagated in culture media.

(5) This finding should greatly facilitate the production of FR in the future. However, it also allows more detailed insights into how the active substance works. "We have known for several years that FR inhibits an important group of signaling molecules in cells, the Gq proteins," explains Cornelia Hermes of the Institute of Pharmaceutical Biology. "That makes FR extremely effective. To date, no other compound is known to inhibit Gq proteins with similar potency."

(6) Hermes together with her colleague Dr. René Richarz, was responsible for a large part of the study now published. One of the questions the researchers explored was, why FR is such a good inhibitor. The molecule consists of two parts, the actual core and a side chain that is attached to it like an arm. Both are produced separately and then linked together. "The side chain is essential for the function of FR," Crüsemann explains. "When it is absent or even slightly modified, the inhibitory effect on Gq proteins decreases significantly."

(7) The function of Gq proteins in the cell is similar to that of the emergency call center of a city: They are the place where various signals from outside the cell converge. This activates them and then in turn certain metabolic processes are switched on or off. Instead of inhibiting numerous signaling pathways, it is therefore sufficient to inhibit the Gq protein to achieve a therapeutic effect. This means that FR is extremely effective, also, if it were administered to the whole body, very toxic. "The goal is, therefore, to administer FR only to cells with pathologically altered behavior," Crüsemann explains.

Bacterial genes can be easily and specifically modified nowadays. "In this way, we can in principle generate FR variants with specific properties, such as those that are transported precisely to certain cells in the body and only do their work there," says the pharmaceutical biologist.

b) Match the terms from the text and their definitions.

Term	Definition
a) bacterium	1. a chronic respiratory disease, often arising from allergies, that is characterized by sudden recurring attacks of labored breathing, chest constriction, and coughing
b) drug	2. a substance that you take to treat a disease or medical problem
c) pharmacist	3. any of various malignant neoplasms characterized by the proliferation of anaplastic cells that tend to invade surrounding tissue and metastasize to new body sites
d) asthma	4. any of various prokaryotic microorganisms of the domain Bacteria that may be free-living, saprophytic, commensal, or pathogenic and that vary widely in terms of morphology, oxygen tolerance, nutritional and temperature requirements, and motility
e) cancer	5. someone whose job is to prepare medicines for sale in a shop or a hospital
f) ingredient	6. a substance in food such as meat, eggs, and milk that people need to grow and be healthy
g) enzyme	7. one of the substances that are combined to make something. The active component of a drug or medicine is the thing that makes it effective
h) gene	8. a natural chemical produced by animal and plant cells that helps reactions and other processes to start
i) inhibit	9. to make it difficult for a process to start or continue in a normal way
j) protein	10. a pattern of chemicals within a cell that carries information about the qualities passed to a living thing from its parents

c) Visit one of the websites <https://academic.oup.com/>, <http://abc-chemistry.org/>, <http://www-jmg.ch.cam.ac.uk/data/c2k/cj/> or any other website publishing research articles in Chemistry, choose an article, read and summarize its content using the plan and useful phrases in the Appendix. The length of the summary should be about 10 % of the original text.

Unit 12. Environmental Chemistry

1. Read the text and explain what environmental chemists are concerned with. Why is environmental chemistry significant?

Environmental chemistry is the discipline concerned with how chemicals are formed, how they are introduced into the environment, how they change after being introduced, the extent to which they enter and where they end up in organisms and other receptors, and the effects they have once they get there.

Environmental chemistry is the scientific study of the chemical and biochemical phenomena that occur in natural places. It should not be confused with green chemistry, which seeks to reduce potential pollution at its source. Environmental chemistry is an interdisciplinary science that includes atmospheric, aquatic, and soil chemistry. It involves understanding how the uncontaminated environment works, which chemicals in what concentrations are present naturally, and with what effects. Without this, it would be impossible to accurately study the effects humans have on the environment through the release of chemicals. Environmental chemists draw on a range of concepts from chemistry and various environmental sciences to assist in their study of what is happening to a chemical species in the environment. Important general concepts from chemistry include understanding chemical reactions and equations, solutions, units, sampling, and analytical techniques.

Contamination. A contaminant is a substance present in nature at a level higher than typical levels or that would not otherwise be there. This may be due to human activity. The term contaminant is often used interchangeably with pollutant, which is a substance that has a detrimental impact on the surrounding environment. In some cases, toxic or harmful effects from contamination do not become apparent immediately. The "medium" (e.g. soil) or organism (e.g. fish) affected by the pollutant or contaminant is called a receptor, whilst a sink is a chemical medium or species that retains and interacts with the pollutant.

Environmental indicators. Chemical measures of water quality include dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), total dissolved solids (TDS), pH, nutrients (nitrates and phosphorus), heavy metals (including copper, zinc, cadmium, lead and mercury), and pesticides.

The major application areas of environmental chemistry are a) risk or hazard assessments of environmental impact; b) management of the environment; c) groundwater protection; d) surface water protection; e) soil protection; f) cleaner production and waste management, including re-use of waste and site remediation.

Source links: <https://helpiks.org/6-38355.html>

<https://www.sciencedirect.com/topics/earth-and-planetary-sciences/environmental-chemistry>

2. Match the terms (1-12), transcriptions (a-l), and translations (i-xii).

1) contaminant	a. [ˈɡri:nˈwɔʃŋ]	i. «зеленый камуфляж»
2) deliquescence	b. [ˈsɪdərəˌfaɪl]	ii. гидрохимия
3) ecotoxicant	c. [ˌsæliˈneɪf(ə)n]	iii. пестицид (ядохимикат)
4) greenwashing	d. [ˈi:kə(v), tɒksɪˈkɒlədʒɪ]	iv. экотоксикология
5) hydrochemistry	e. [ˌdelɪˈkwesəns]	v. смог
6) siderophile	f. [ˈnju:triənt]	vi. загрязняющий агент/радионуклид
7) smog	g. [kənˈtæmɪnənt]	vii. сидерофильный
8) bioavailability	h. [smɒɡ]	viii. минерализация, засоление (почвы)
9) ecotoxicology	i. [ˈpestɪsaɪd]	ix. питательное вещество
10) pesticide	j. [ˈi:kə(v)ˈtɒksɪkənt]	x. расплывание за счет атмосферной влаги/гигроскопичность
11) nutrient	k. [ˌbaɪəʊəˌveɪləˈbɪlɪtɪ]	xi. биодоступность
12) salination	l. [ˈhaɪdrəvˈkemɪstrɪ]	xii. экотоксикант

3. For each definition (a-f) choose a suitable term from task 2 (1-12).

- Air pollution consisting of smoke and fog, caused by the action of sunlight on unburned hydrocarbons and nitrogen oxides, mostly from car exhaust. It occurs over large industrial areas and urban complexes and causes eye irritations, breathing problems, and damage to plant life.
- An expression of the fraction of the total mass of a compound present in a compartment that has the potential of being absorbed by the organism.
- A substance that makes something less pure, pollutes, spoils, or poisons something.
- The accumulation of soluble salts by evaporation of the waters that bore them to the soil zone, in a soil of an arid, poorly drained region.
- A group of chemicals used for the control and prevention of pests such as fungi, insects, nematodes, weeds, bacteria, and viruses.
- That part of hydrology that deals with the chemical characteristics of bodies of water.

- g. A relatively young field that was defined as “the branch of toxicology concerned with the study of toxic effects, caused by natural or synthetic pollutants, to the constituents of ecosystems, animal (including human), vegetable and microbial, in an integral context”.
- h. The practice of promoting environmentally friendly programs to deflect attention from an organization's environmentally unfriendly or less savory activities.
- i. Capable to form alloys easily with iron and concentrated in the Earth's core (described by the Goldschmidt classification).
- j. Chemical elements which are involved in the construction of living tissue and which are needed by both plant and animal. The most important in terms of bulk are carbon, hydrogen, and oxygen, with other essential ones including nitrogen, potassium, calcium, sulfur, and phosphorus.
- k. A toxic or poisonous substance, chemical, physical or biological agents affecting the entire ecosystem.
- l. The process by which a substance absorbs moisture from the atmosphere until it dissolves in the absorbed water and forms a solution.

4. Complete the following paragraphs using the terms studied in task 2. In some sentences, the plural form is required. In each paragraph, the same word is missing.

- 1) Groundwater contains a wide variety of dissolved inorganic constituents as a result of chemical interactions with geological materials and to lesser extent contributions from the atmosphere. The study of _____ is of prime importance in deciding about the quality of groundwater supply. _____ helps to evaluate hydrogeochemical processes responsible for temporal and spatial changes in the chemistry of groundwater.
- 2) This kind of _____ is caused by the burning of large amounts of coal within a city; this _____ contains soot particulates from smoke, sulfur dioxide, and other components.
- 3) Processes, which recover sodium or potassium chlorides from natural brines originating from the ocean or salt lakes, have the least _____ impact on surrounding lands. Since many of these operations use solar evaporation, they also have a low external energy requirement. The ecological and human impacts of rising oceans would be substantial, including increased flooding, coastal erosion, _____ of aquifers, and loss of coastal agricultural land and living space. Stable agricultural systems together with a massive increase in tree planting, which reduce or eliminate erosion, _____, and other factors leading to the loss of productive land, need to be developed in order to ensure the necessary food security for human society to be stable.

- 4) _____ occurs when the vapor pressure of the solution that is formed is less than the partial pressure of water vapor in the air. All soluble salts will deliquesce if the air is sufficiently humid. A substance that absorbs moisture from the air but not necessarily to the point of dissolution is called hygroscopic. The effectiveness of calcined calcium chloride in settling road dust is a result of its _____. When spread in the form of a powder or flakes, it absorbs more than its weight of water and forms a liquid that keeps the road wet.
- 5) Despite the _____, it's not clear to me that he really intends to take strong action on climate change. Privately, some haulers accuse each other of _____, or falsely hyping their environmental credentials. _____ involves taking an existing product and spinning its environmentally-friendly virtues even if there are none.
- 6) In areas of accumulation of ore-forming elements the _____ elements, as a rule, form zones of lower concentrations relative to the background concentration. Experience shows that these zones most probably contain ore bodies and deposits of commercial significance. Researchers followed the evolution of _____ trace elements and light atomic elements incorporation into the core, and how they were linked.
- 7) This _____ is toxic, persistent, and long-lived in the atmosphere, and can be transported globally. These should be determined by comparing _____ levels with government guidelines or by conducting site-specific risk assessments. The Panel concludes that carbon tetrachloride is not added at any stage during the process employed in the United States but is instead a by-product that is removed as an unwanted _____.
- 8) The kinetics of _____ transport through the membrane was studied. The _____ studied were pesticides widely used in agriculture. Technogenic _____ xenobiotics (foreign substances for living cells), such as pesticides, are presently pre-dominant contaminants of the environment.
- 9) _____ are ubiquitous contaminants of the human environment and, as such, not only interact with hepatic enzymes as substrates, inhibitors, activators, and inducers but are also involved as the causative agents of numerous toxic endpoints. While the exposure of the general public to _____ and their metabolites is usually low, exposures are of concern in occupational and other settings.
- 10) Biological availability, _____, is a dynamic concept that considers the physical, chemical, and biological processes of contaminant exposure and dose. In the ecotoxicology literature, _____ has been used nonspecifically, in part because no single definition is recognized. _____ incorporates concepts in environmental chemistry and ecotoxicology integrating contaminant concentration, fate, and an organism's behavior in the environment.

- 11) _____ deals with the fate and effects of contaminants in the biosphere. Contrary to human toxicology, which is concerned with the effects of chemicals on the individual organism, _____ is concerned with toxic effects on ecological entities, i.e. populations, communities, or ecosystems. In practice, however, _____ builds on conventional toxicological endpoints which are determined in selected sentinel species or species representing trophic levels in a food chain and infers from these individual-level effects to processes at higher levels of biological organization.
- 12) The _____ profile of a particular food provides information about the presence of _____ known to affect health, e.g. high concentrations of sodium, saturated fatty acids, or sugars. Numerous methods are adopted to create _____ profiles, e.g. scoring models or special indices, and these have been the subject of some debate.

5. Match the terms (1-19), their transcriptions (a-s), and translations (i-xix).

1) acid rain	a. [gri:n/səs'teɪnəbl 'kemɪstrɪ]	i. растворитель, не участвующий в атмосферных фотохимических реакциях, приводящих к образованию смога
2) aerosol filtration	b. [i:kə'lɒdʒɪkl'rɪskə'sesmənt]	ii. парниковый газ
3) atmospheric chemistry	c. ['əʊʃ(ə)n ə'sɪdɪfɪ,keɪʃ(ə)n]	iii. стратосферный озон
4) exempt solvent	d. ['mæksɪmə'm'rezɪdʒu:'lɪmɪt]	iv. закисление океана
5) global sulphur cap	e. [ˌreɪdɪəv'æktɪv'fɔ:ləʊt]	v. термическая обработка отходов
6) green/sustainable chemistry	f. ['eəɾəsəl fɪl'treɪʃ(ə)n]	vi. кислотный дождь
7) maximum residue limit	g. [ˌtrɒpə'sferɪk ('sɜ:fɪs) 'əʊzəʊn]	vii. экологически безо- пасная химия/химия в интересах устойчивого развития
8) ocean acidification	h. ['gləʊb(ə)l'sɒlfə,kæp]	viii. геохимия изотопов
9) persistent organic pollutant (POP)	i. ['gri:nhaʊs'gæs]	ix. атмосферная химия
10) stratospheric ozone	j. ['æsɪd'reɪn]	x. атмосферные выбросы
11) supercritical flow	k. [ˌsu:pə'krɪtɪk(ə)l'fləʊ]	xi. залповое движение потока/сверхкритичес- кий режим потока
12) thermoselect process	l. ['aɪsətəʊp'dʒi:əv'kemɪstrɪ]	xii. внешнее воздействие на климат; климато- образующий фактор

13) tropospheric (surface) ozone	m. [pə'sɪstənt ə'gænik pə'lu:t(ə)nt]	xiii. предельно допустимый уровень остаточного содержания
14) atmospheric emissions	n. ['æt mə'sferɪk 'kemɪstrɪ]	xiv. аэрозольная фильтрация
15) greenhouse gas	o. ['θz:məʊsɪ'lekt 'prəʊses]	xv. радиоактивный осадок
16) Ecological Risk Assessment	p. ['klaɪmət 'fə:sɪŋ]	xvi. серная директива
17) isotope geochemistry	q. [,strætə'sferɪk 'əʊzəʊn]	xvii. оценка экологического риска
18) radioactive fallout	r. ['æt mə'sferɪkə'mɪʃnz]	xviii. стойкий органический загрязнитель (СОЗ)
19) climate forcing	s. [ɪg'zempt 'sɒlvənt]	xix. тропосферный/ приповерхностный озон

6. For each definition (1-19) choose a suitable term (word combination) from task 5.

- 1) A liquid substance capable of dissolving other substances that is not involved in atmospheric photochemical reactions leading to smog formation.
- 2) One of the most important causes of diffuse pollution, and contaminants emitted into the atmosphere may reach the soil due to wet or dry deposition of particles, at a rate dependent on their size and density.
- 3) A process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors.
- 4) Radioactive material produced by a nuclear explosion or a nuclear reactor accident that enters the atmosphere and eventually falls to Earth that consists of minute, radioactive particles of dust, soil, and other debris.
- 5) A flow whose velocity is larger than the wave velocity. The flow at which depth of the channel is less than critical depth, the velocity of flow is greater than critical velocity and the slope of the channel is also greater than the critical slope (Civil Engineering Terms website).
- 6) Gases in the atmosphere that absorb and emit thermal radiation in a process known as the greenhouse effect – the mechanism by which solar radiation is captured and earth is warmed to an extent necessary for supporting life.
- 7) An organic compound that is resistant to environmental degradation through chemical, biological, and photolytic processes.
- 8) Directive on the limitation of the maximum sulfur content.
- 9) A scientific field designed to make chemical industries and their products as safe as possible for human health and the environment.

- 10) A device containing a porous substance for trapping aerosols when cleaning air or any gases released into the atmosphere.
- 11) The maximum concentration of a residue that is legally permitted or recognized as acceptable in or on a food or agricultural commodity or animal feedstuff.
- 12) A gaseous layer produced in the upper stratosphere by short-wave sunlight, which together with chemical reactions dissociates again to create a dynamic balance between production and loss, that protects the earth's surface from damaging short-wave ultraviolet (UV) radiation.
- 13) A secondary pollutant formed from emissions of nitrogen oxides, non-methane volatile organic compounds, and carbon monoxide, that scars lung tissue, makes eyes sting and throats itch. It has been implicated as a contributor to forest dieback, damage to crops, etc.
- 14) The study of the relative and absolute concentrations of the elements and their isotopes in samples from the Earth and solar system. Such measurements offer a powerful tool to interrogate a range of scientific problems from the origins of the terrestrial planets, to past climate change, to igneous processes and the source of elements in a variety of geological reservoirs.
- 15) The rain having a pH of less than 5.6. The acidity results from chemical reactions occurring when water, sulfur dioxide, and nitrogen oxides, generally released by industrial processes, are chemically transformed into sulphuric and nitric acids.
- 16) The study of the production, transport, modification, and removal of atmospheric constituents in the troposphere and stratosphere. A branch of atmospheric science in which the chemistry of the Earth's atmosphere and that of other planets is studied. It is a multidisciplinary research approach that draws on environmental chemistry, physics, meteorology, computer modeling, oceanography, geology, volcanology, and other disciplines.
- 17) The ongoing decrease in the pH of the Earth's oceans, caused by the uptake of anthropogenic carbon dioxide from the atmosphere.
- 18) A thermic waste processing technology that is trying to achieve higher electrical efficiencies and lower emissions, gasification is emerging as an alternative to combustion in the treatment and energy recovery from Municipal Solid Waste.
- 19) The difference between the rate of energy received by absorption of solar radiation and the rate of energy emitted by the top of the Earth's atmosphere expressed in watts per square meter.

7. Complete the following paragraphs using the terms studied in task 5. In some sentences, the plural form is required. In each paragraph, the same phrase is missing.

- 1) _____, also called _____, is a new field that encourages the design and development of chemicals using principles that minimize the use and generation of toxic chemicals.
- 2) _____ is a completely new solid waste treatment process that achieves pollution-free recycling of municipal solid waste and industrial waste by high-temperature gasification and reforming process. The process effectively recovers fuel gas from waste and recycles metal and other byproducts as resources.
- 3) _____ pollution is discussed from the scientific and regulatory perspectives. Adverse effects of acid deposition and transboundary acidification are introduced first. Then, observational efforts and results are elaborated for _____ precursors, components, and depositions in the USA and China. After that, a photochemical mechanism is presented to describe the formation of inorganic sulfate and nitrate in the global troposphere from anthropogenic emissions.
- 4) _____ is normally measured using stationary equipment, such as a Dobson spectrometer and filter ozonometer, which have the disadvantages of large size, high price, and high cost for operation and maintenance. The main chemicals that are depleting _____ are chlorofluorocarbons, which are used in refrigerators, aerosols, and as cleaners in many industries, and halons which are used in fire extinguishers. The damage is caused when these chemicals release highly reactive forms of chlorine and bromine.
- 5) Radiogenic _____ plays a significant role in modern-day scientific research for resolving the chronology of rock-forming events. _____ is an attribute of relative and absolute concentration of elements and their isotopes on Earth. Variations in the abundance of these isotopes can be measured by an isotope ratio mass spectrometer. The information reveals the age of rocks and minerals or sources of air and water.
- 6) _____ is an exciting, relatively new field. It encompasses the chemistry of the globe, from polluted to “clean,” remote regions and from the region closest to the earth’s surface, the troposphere, through the tropopause, into the upper atmosphere. Chemical and physical processes occurring at the earth’s surface emissions, transport, lifetimes, and fates of certain anthropogenic and biogenic/geogenic chemicals can impact the stratosphere and vice versa. The field of _____ research is composed of three pillars: laboratory, modeling, and field studies. These disciplines are all essential to understanding and characterizing the atmosphere.

- 7) _____ will enter into force in 2020, and more than 70,000 ships will be affected by the regulation. Stricter limits on sulfur (SO_x) emissions are already in place in Emission Control Areas (ECAs) in Europe and the Americas, and new control areas are being established in ports and coastal areas in China. As a result, ship owners are weighing their options to ensure compliance.
- 8) _____ is included in the outline among the topics to be covered by the First Global Integrated Marine Assessment. Ongoing acidification of the oceans also poses a threat to the food chains connected with the oceans. As members of the InterAcademy Panel, 105 science academies have stated _____. The statement recommends that by 2050, global CO₂ emissions be reduced by at least 50%, compared to the 1990 level. The Declaration introduced several policy recommendations to enhance coral reef resilience to _____.
- 9) _____ is considered a greenhouse gas and may contribute to global warming. Photochemical and chemical reactions involving ozone drive many of the chemical processes that occur in the troposphere. At abnormally high concentrations (the largest source being emissions from combustion of fossil fuels), it is a pollutant and a constituent of smog.
- 10) _____ using fibrous filters has been well documented whereby particle capture occurs by mechanical means such as Brownian diffusion, interception, or impaction. In addition, several researchers have coupled electrostatics with mechanical particle capture mechanisms, to achieve higher filtration efficiencies for the same pressure drop by charging the particles or the filter or both.
- 11) The calculation of VOC for two-component, _____ coatings in terms of lbs./gal., less water, and _____ is discussed. The two components are mixed in a ratio of 1:1 by volume, while this coating does not contain water. It is needed to mix the two components in equal amounts by volume, just as they are mixed by the painter. After mixing, the total amount of non-exempt VOC is divided by the volume of (solid + VOC). The _____ can be eliminated from the mixture by using the volume of (solid + VOC), which yields the calculation result. The coating, based on this calculation, is right at the regulatory limit for an Aerospace primer under the Aerospace NESHAP.
- 12) The inventive method consists in carrying out a rubber crumb thermolysis in a fluidized layer in the vertical _____ of a hydrocarbon alkylaromatics-containing gas. Difficulties that arise in solving for _____ conditions using the method of finite differences date back to the 1960s when implicit numerical schemes were first used in the solution of one-dimensional free-surface flows.
- 13) Today, environmental radiation monitoring in the vicinity of nuclear power facilities has become more important than _____ surveillance, since 38 nuclear power

plants are already in operation or under construction in Japan. Environmental radiation monitoring in Japan mainly comprises two different systems. One is radiation measurements and radioactivity analyses of various samples taken from the vicinities of 14 nuclear facilities and the other is a nationwide network consisting of 47 public hygiene institutes of local government with countermeasures against the _____ due to nuclear explosion tests or a severe accident in a foreign country, such as the Chernobyl accident.

- 14) A _____ is the maximum concentration of a pesticide residue resulting from the use of a pesticide according to good agricultural practice directly or indirectly for the production and/or protection of the commodity for which the _____ is recommended. The _____ should be legally recognized. It is expressed in milligrams of the residue per kilogram of the commodity. The expression “_____” replaces the formerly used “tolerance” in accordance with the practice initiated by the 1972 Joint Meeting.
- 15) The basis for future climate projection is that climate variations are driven by changes in _____. Therefore, to simulate future climate, we need to specify the future _____ in the models. _____ can be classified into two types: natural and anthropogenic. Natural _____ are due to solar radiation changes and volcanic eruptions, while anthropogenic changes are due to human activities that alter the properties of the Earth system.
- 16) _____ are fat-soluble and thus accumulate in the fatty tissue of fish and other animals over time. _____ is a group of organic compounds (pesticides, dioxins, furans, and PCBs). _____ bioaccumulate in food chain affecting the environment and human health.
- 17) The concept of ecological risk is developed within the context of _____. Conceptual frameworks and methodologies for _____ are being developed internationally. _____ is the process of estimating the likelihood that a particular event will occur under a given set of circumstances, aiming to provide a quantitative basis for balancing and comparing risks associated with environmental problems and a systematic means of improving the estimation and understanding of those risks.
- 18) _____ accompany most of the crude oil and natural gas operations and according to some estimates up to 30% of the hydrocarbons emitted into the atmosphere during well testing precipitate onto the sea surface and create distinctive and relatively unstable slicks around the offshore installations.
- 19) Each _____ possesses a unique heat-trapping power and lifetime in the atmosphere. Having taken CO₂ as the reference point of _____, global warming potential is a tool to compare the potential of those various gases in terms of their heat-trapping capacity in the atmosphere compared to CO₂ over a specified time.

8. Make words or word combinations by putting the entangled letters in the correct order.

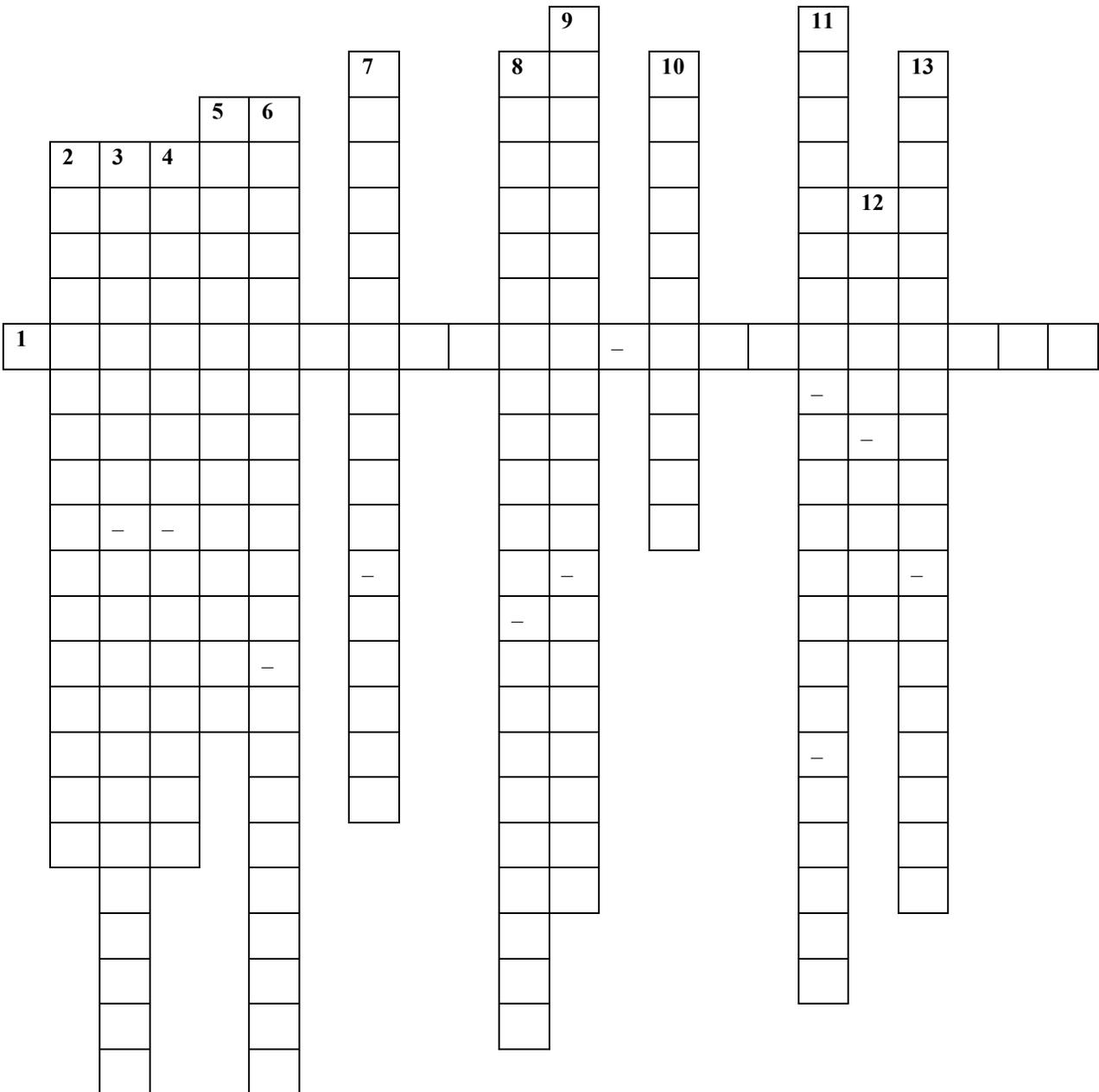
- | | |
|------------------------|-------------------------|
| 1. dqleeesuceinc | 7. amrcitoneligfc |
| 2. cioaecacionnaidfti | 8. tcmaihcopehreyrsimst |
| 3. hrcosogtistyemopeie | 9. ptoneeexmvtsl |
| 4. oemrystrdihych | 10. roosahcenzroteitsp |
| 5. liiliaavabiotby | 11. gycteoloooixc |
| 6. onsfaiteltoraorl | 12. creomhtpsetcelserso |

9. Put the parts in order to form a sentence.

- 1) Bioavailability/ like/ factors,/ route of/ is dependent/ and the physiological/ attributes/ exposure,/ soil/ abiotic/ characteristics,/ of the exposed/ and biotic/ organisms/ on many/
- 2) Because/ the occurrence/ water/ the government/ expected/ pesticides/ would prohibit/ it might be/ pesticide/ that/ of any/ in drinking/ are toxic,/
- 3) The objective/ assessment/ in the environment/ pollutants/ of such/ is to obtain/ due to/ the presence/ of ecotoxicology/ data/ for risk/
- 4) In the chemicals/ chemistry,/ and sound/ issues/ deployment/ stewardship/ product/ broader/ practice of/ sustainable/ are the key/ and the ongoing/ area,/ "Responsible Care"/
- 5) Acid rain/ from the combustion/ arises/ of fossil fuels/ in the air/ and the release/ of sulfur/ and nitrogen/ oxides/
- 6) Stratospheric/ sunlight/ is produced/ ozone/ in the upper/ by short-wave/ stratosphere/ from oxygen/
- 7) As the deadline/ switch/ many/ of preparing/ is getting/ still remain,/ more/ closer,/ the job/ sulphur cap/ vessels/ making/ challenging/ for the fuel/ for the global/ uncertainties/
- 8) Ocean/ shell/ affects/ or skeleton,/ that produce/ a calcium carbonate/ negatively/ shellfish/ organisms/ such as/ acidification/ many/ and corals/
- 9) Although/ ozone/ it is/ than/ of concern/ stratospheric/ tropospheric/ because of/ concentrated/ its health/ effects/ is less/ ozone,/
- 10) The wettability/non-wettability/ of liquid/ filtration/ aerosol/ important/ is one of the most/ parameters/ to the liquid/ in relation/ fibers/ aerosol/ of the filter/
- 11) The relationship/ and the magnitude/ the magnitude/ forcing/ between/ change/ of the climate/ of the climate/ response/ defines/ sensitivity/ the climate/
- 12) Persistent/ organic/ and do not/ that are/ pollutants (POPs)/ compounds/ are organic/ degrade/ easily/ stable/

- 13) Ecotoxicological/ assessment/ these/ of organization/ are addressing/ in an ecological/ tools for/ models/ risk/ higher levels/ important/
 14) Increasing/ of fossil fuels/ have already/ climate/ emissions/ Earth's/ of CO₂/ atmospheric/ anthropogenic/ and other/ from the burning/ sources/ affected/

10. Solve a crossword puzzle using the terms of this unit.



1) The branch of atmospheric science focused on chemical processes within the Earth's atmosphere, including photochemistry of gas compounds; the formation and properties of airborne aerosol particles; gas-particle interactions; etc.

- 2) _____ describes many complex processes, including the mass transfer and uptake of contaminants into organisms, which are determined by substance properties, compartment properties, the biology of organisms, and climatic influences.
- 3) Radiogenic _____ can help with the evaluation of the above models for accretion by determining the rates of growth of the silicate reservoirs that are residual from core formation.
- 4) The changes in climate that result from human activities occur gradually in response to steadily increasing _____ by greenhouse gas increases, aerosol production, and land surface modification.
- 5) Practical eco-toxicologists apply technical tools of _____ to estimate the risk and suggest remediation actions for specific contamination events.
- 6) In spite of the fact that some countries now prohibit flaring of crude oil-associated gases, it remains one of the major sources of _____ in the world.
- 7) _____ generated through the burning of agricultural crop residues and the utilization of petroleum products derived from fossil fuels (in the transportation sector) are predominant contributors to global warming.
- 8) Industry has a special responsibility, as designer, producer and user of chemicals and products, and should apply _____, recognizing the ongoing efforts being undertaken in this regard.
- 9) Radioactive contamination can result from either expected or accidental release of radioactive materials during the treatment of uranium and thorium ores, the operation of nuclear reactors, or the application of radionuclides and labeled compounds in medicine, research, industry, and agriculture, as well as from _____ from the atmosphere.
- 10) _____ are chemical agents used since the beginning of human history to eradicate or to control undesired organisms (“pests”) in agriculture, animal breeding and public health.
- 11) Pesticide residue monitoring against regulated _____ is important in ensuring that crops to which pesticides have been applied are safe for humans and animals.
- 12) _____ is formed when sulfur dioxide and nitrogen oxides react with water vapor and other chemicals in the presence of sunlight to form various acidic compounds in the air.
- 13) PCBs, dioxins, and furans are _____ pollutants that have negative effects on the environment and health of humans.

11. Reading and discussion.

Read the text and explain in what way iodine affects climate change. Iodine-containing molecules contribute to the formation of atmospheric aerosols and affect climate

Source link: <https://www.sciencedaily.com/releases/2021/02/210208085521.htm>

Date: February 8, 2021

Source: Carnegie Mellon University

As part of worldwide collaboration, Carnegie Mellon University chemists have helped discover that iodic acids can rapidly form aerosol particles in the atmosphere, giving scientists more knowledge of how iodine emissions can contribute to cloud formation and climate change.

“Essentially all uncertainty around climate change and the atmosphere has something to do with particles and cloud droplets,” said Neil Donahue, Thomas Lord University Professor of Chemistry. The Donahue lab has been a longtime member of the CERN CLOUD experiment, an international collaboration of scientists that use a special chamber at CERN in Switzerland to remedy that uncertainty by studying how cosmic rays affect the formation of particles and clouds in the atmosphere. The chamber allows researchers to precisely mix vaporous compounds and observe how particles form and grow from them.

In a study published today in the journal *Science*, the CLOUD collaboration looked in particular at how vapors containing iodine affect this nucleation process. For reasons not yet fully understood, Donahue said, concentrations of iodine-containing vapor compounds have been increasing in recent years in the atmosphere.

Building on previous research his lab conducted on discovering a new rapid mechanism for atmospheric particle formation from nitric acid and ammonia vapors, Donahue and his team have now helped the CLOUD collaboration discover that the nucleation rates of iodic acid particles are very fast. This means that increasing concentrations of iodine-containing vapors in the atmosphere can lead to large increases in the number of particles that form clouds.

Specifically, Donahue and his collaborators contributed their use of a state-of-the-art chemical ionization mass spectrometer that can measure the amount and composition of extremely small particles less than 10 nanometers in size just following their formation.

“The CMU measurements showed that the newly formed particles are composed largely of iodic acid, confirming that this critical molecule not only is present as a vapor while particles are forming but definitively drives their growth,” Donahue said.

Clouds play an important role in regulating Earth’s temperature because they are highly reflective. Much of the sun’s energy is reflected by clouds back into space, keeping Earth from becoming too hot. However, that reflectivity can work both ways, which is a particular problem at Earth’s poles. Typically, the white snow and ice surfaces reflect a lot of sunlight into space, thus keeping the surface there cool. However, increased cloud formation in those regions can mean that the light reflected off the surface can be reflected onto the ice and snow by the clouds.

“The Arctic is an especially vulnerable region, with twice the rate of warming and the huge consequences of both sea ice and ice sheet melting,” Donahue said. He and his lab are already planning future research into the complex feedbacks between iodic acid and sulfur compounds and how these affect the polar atmosphere and climate change.

a) Answer the questions:

- 1) What was the Cern Cloud experiment in which Neil Donahue was a participant?
- 2) What research from Neil Donahue's lab helped the Cloud investigate the effects of iodine emissions?
- 3) How did Donahue help the Cloud collaboration study the effect of iodine vapor on climate change?
- 4) How did the scientists can determine the composition of the particles formed (nucleation)?
- 5) How can cloud formation, facilitated by iodic acid vapors, affect the climate and atmosphere?

b) Match the terms and their definitions:

Term	Definition
1) cosmic ray	a) microscopic bits of dust, soot, and sea spray suspended in the air, that are ubiquitous in the troposphere and exert an important influence on global climate and the environment
2) nucleation	b) the strength of a solution; number of molecules of a substance in a given volume
3) chemical ionization	c) the extremely localized budding of a distinct thermodynamic phase, the first stage of a phase transition in a small region
4) aerosol particles	d) very high-energy particles, mainly originating outside the Solar System, highly penetrating ionizing radiation of extraterrestrial origin; consisting chiefly of protons and alpha particles
5) concentration	e) an increase in the average temperature of the earth's atmosphere (especially a sustained increase that causes climatic changes)
6) warming	f) a branch of gaseous ion-molecule chemistry, a soft ionization technique used in mass spectrometry

c) Visit one of the websites <https://academic.oup.com/>, <http://abc-chemistry.org/>, <http://www-jmg.ch.cam.ac.uk/data/c2k/cj/> or any other website publishing research articles in Chemistry, choose an article, read and summarize its content using the plan and useful phrases in the Appendix. The length of the summary should be about 10 % of the original text.

Приложение

1. Summary: sample structure and useful phrases.

Structure	Useful phrases
1. The title	The title of the article is "..."
2. The author (authors)	The author of the article is... / The authors of the article are... The article is written by... He/she is a professor at ... He/she conducts research on ... and is famous for...
3. Where and when the work was published	The article under consideration was published in the scientific journal "...” in 2021. The article is available on the website...
4. The main idea / the purpose of the article	The article is devoted to... The article deals (is concerned) with... The article touches upon the issue of... The objective of the study is... The purpose of the article is to give the reader some information on... The article aims to provide the reader with some material on...
5. The structure of the article. Some facts, names, figures.	The article is divided into ... parts. The first part ... The second part... The author starts by + V_{ing} . The author reports (states, stresses, thinks, notes, believes, points out) that... The authors consider (analyze, describe) ... + what? Much attention is given to... According to the article,... The article/author goes on to say that... It is reported (shown, stressed) that ... It is spoken in detail about... From what the author writes it becomes clear that... The fact that ... is stressed. The article gives a detailed analysis of... Further, the author reports... In conclusion, the author reports (states, stresses, thinks, notes, points out) that...

6. Methods	<p>All the experiments were carried out using ...</p> <p>Several techniques have been used to investigate...</p> <p>The measurements... were conducted using...</p> <p>This method proves to be...</p> <p>In order to identify / understand / investigate / study / analyze</p> <p>The authors develop (offer, provide, rely on, work out, use) a method of...</p> <p>This method enables predictions of... / allows discussions on...</p> <p>X was carried out / performed / analyzed / calculated / determined using</p>
7. Results and discussion	<p>The author comes to the conclusion that...</p> <p>The following conclusions are drawn: ...</p>
8. Target audience	<p>The paper is interesting/informative for...</p>

2. Sample summary.

Study the summary of a research article. Pay attention to the phrases from the table above.

The title of the article is “Rapid Biosynthesis Method and Characterization of Silver Nanoparticles Using Zizyphus Spina Christi Leaf Extract and Their Antibacterial Efficacy in Therapeutic Application”. **It was published in** the “Journal of Biomaterials and Nanobiotechnology” in 2017 and **is available on the website** <https://www.researchgate.net>. **The author of the article is** Eman Mohamed Halawani from the Biology Department, Taif University, Taif, Saudi Arabia.

The purpose of the text is to describe an ecofriendly and rapid method to synthesize silver nanoparticles using Zizyphus spina christi L aqueous leaves extract (ZSE). The antibacterial properties of the material have been studied for the first time. The extract is found to have the potential to form silver nanoparticles at room temperature within few minutes. The green synthesized silver nanoparticles and their antibacterial activity are determined and characterized using different techniques. The research is crucial for the medical application of silver nanoparticles.

The article is divided into four parts. The paper begins with a short discussion of the value of nanoparticles, known methods for their chemical synthesis and synthesis on biological systems. **The present work is focused on** a green technology that uses the aqueous plant extract for the biosynthesis of silver nanoparticles without the usage of hazardous and toxic solvents.

The second part describes the main methodology for preparing the extract of plant leaves and the synthesis of silver nanoparticles. The synthesized silver nanoparticles are characterized using different techniques such as UV-Vis Spectra Analysis, Transmission Electron Microscope (TEM), Fourier Transform Infrared Spectroscopy (FT-IR), and X-Ray Diffraction (XRD). The antibacterial activity of AgNPs is determined by the diffusion and microplate assay methods. Furthermore, the particles are loaded on band-aids and screened for antibacterial activity.

In the next part, the author presents the results of synthesis and analysis. The UV-visible spectrum of the solution containing AgNPs showed a peak at 414 nm corresponding to the plasmon absorbance of silver nanoparticles. The transmission electron microscopy (TEM) revealed that the formed particles were hexagonal with appreciable Nano size ranging from 21.5 to 59.67 nm. Fourier Transform Infrared Spectroscopy analysis (FTIR) of biosynthesized AgNPs affirmed the role of ZSE as reducing and capping agent of Ag⁺ ions to AgNPs, and X-Ray Diffraction patterns (XRD) showed that they could be indexed as a face-centered-cubic structure of silver. An antimicrobial assay gave maximum inhibition zones of 24 mm, 23 mm, 15 mm, and 17 mm against *Staphylococcus aureus*, *Acinetobacter* sp., *Pseudomonas aeruginosa*, and *Escherichia coli*, respectively. The minimum inhibitory concentration (MIC) and the minimum bactericidal concentration (MBC) results showed that AgNPs had MIC, MBC of 45, 57 µg/mL, 49, 61 µg/mL, 63, 90 µg/mL, and 59, 82 µg/mL against *S. aureus*, *Acinetobacter* sp., *P. aeruginosa*, and *E. coli*, respectively. The AgNPs loaded on band-aids exhibited a strong antibacterial effect against multi-drug-resistant bacteria.

The last part discusses the results of the study. Silver nanoparticles prepared in this process proved to be fast, low cost, eco-friendly, and could be potentially applied in a variety of solutions for safe medical application. These nanoparticles could be used for treating wounds and preparing wound dressing.

The paper I have read is informative for biochemists and people interested in physical chemistry and biochemistry.

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