TOMSK POLYTECHNIC UNIVERSITY

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PROFESSIONAL ENGLISH FOR CHEMISTRY STUDENTS

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Федеральное государственное автономное образовательное учреждение высшего образования
**«НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»**

А.С. Сачкова, А.Г. Богданова, Е.О. Захарова

ПРОФЕССИОНАЛЬНЫЙ АНГЛИЙСКИЙ ДЛЯ СТУДЕНТОВ-ХИМИКОВ

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Пособие состоит из четырех тематических разделов, в каждом из которых представлены тексты, а также вариативные задания, направленные на закрепление усвоенного материала.

Предназначено для студентов химико-технологических направлений с целью формирования у них навыков письменной и устной коммуникации на английском языке в практических целях для осуществления профессиональной деятельности.

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INTRODUCTION

Dear learner,

We are excited that you are joining us for the course "Professional English for chemistry students". Aiming to make your learning experience interesting we have taken care to introduce a variety of activities for the acquisition of the target skills for successful performance in an English-speaking professional environment through Reading, Speaking, Listening and Writing. You will read authentic texts, watch authentic videos, complete a wide range of tasks that enable language practice as well as acquisition of professionally relevant knowledge through classroom interaction, working on oral and written assignments.

Best regards,
Authors

Lead-in

Vocabulary


Reading


Speaking

Watching/Listening


Writing focus


Group work


Self-assessment

MODULE 1
INTRODUCTION TO CHEMISTRY AND ENGINEERING

http://www.pristoninternational.com/course-tag/chemistry

Let’s get acquainted

Ice-breaking games:

1. **My life in five sentences.** Introduce yourself and tell about your life in five sentences. Consult Table 1 for some useful structures and phrases.

Table 1

Useful Language for Introducing Yourself

- ***Let me introduce myself… My name is …***
- ***I’d like to introduce myself. I’m ...***
- ***to major in something***: to study something as your main subject at college or university (*Example: She majored in Chemistry at Harvard).*
- ***to minor in something****: to study something as your second most important subject in college or a university (Example: I minored in Biology in college).*
- ***to be good at something****: to be very skilled at doing something (Example: I’m very good at creative thinking).*
- ***to have a short-term/ long-term goal:*** to have some aim that you hope to achieve in the near future/ more distant future *(Example: My short-term goal is to take an IELTS Preparation Course. My long-term goal is to get my master’s degree in Engineering).*

2. **Two truths and a lie**. Tell two truths and a lie about yourself and have your fellow-students and the teacher guess which statement is the lie.
3. **Interview.** Interview one of your fellow-students about their latest academic achievements. Ask them to share some secrets of learning successfully.

Questions to discuss:

1. What makes a good student?
2. Are you an aspiring person? What are your short- and long-term goals?
3. What do you prefer: receiving advice or giving advice to someone?
4. How often do you go online? Describe a useful website for learning English/ professional subjects?
5. What are your expectations, wants and needs from this course?

***Task 1.* Work in groups of three to four students. Comment on the quotations employing the phrases useful to express opinion from Table 2.**

1. "*The country which is in advance of the rest of the world in chemistry will also be foremost in wealth and in general prosperity*". – **William Ramsay**
2. "*Engineering or technology is the making of things that did not previously exist, whereas science is the discovering of things that have long existed*". – **David Billington**

Table 2

Useful Language: Phrases to Express Opinion

- *In my opinion, ...*
- *To my mind, ...*
- *From my point of view, ...*
- *As far as I am concerned, ...*
- *My view / opinion / belief / impression / conviction is that ...*
- *I think / consider / find / feel / believe / suppose / presume / assume that ...*
- *I hold the view that ...*
- *It goes without saying that ...*
- *I have no doubt that ...*
- *It seems to me that ...*
- *I am under the impression that ...*
- *I dare say that ...*
- *My own feeling on the subject is that ...*
- *I am sure / I am certain that ...*

Task 2. **You are going to watch the video "Chemistry careers – A day in the work life of a chemist" (https://www.youtube.com/watch?v=0eeDUCgJDU4) where Hilary Corkran is talking about her job of a process development chemist. Cover the questions and tasks below.**

Pre-watching tasks and questions.

1. What makes a good scientist in your opinion?
2. What does the career of a process development chemist involve? Is it in demand on the job market?
3. What skills are important for this career?
4. Study the suggested list of professional skills for the career of a process development chemist. Arrange them in order starting from the most important to the least important one:

- *capable of working well under pressure;*
- *capable of working well within a team environment;*
- *good communication skills;*
- *good IT skills;*
- *an analytical approach to problem solving;*
- *good maths skills.*

Would you like to extend the suggested list?

https://www.shutterstock.com/ru/image-photo/young-female-scientist-nurse-works-on-56260687

After-watching tasks and questions.

1. What company does Hilary work for? What are her job responsibilities?
2. How does she describe some challenges related to her job?
3. What makes the job of a process development chemist really appealing and satisfying to Hilary?
4. Describe Hilary's career path as a chemist. How do you see your own career path? Are you going to gain any additional degrees after graduation?
5. Why can working in the laboratory be challenging and rewarding at the same time?

***Task 3.* Watch the video from the Vlog of Sophie, a third year undergraduate in chemistry from the University of Birmingham (https://www.youtube.com/watch?v=oNtu9P5lkkE&feature=emb_title). Fill in the gaps with the words from Table 3.**

https://www.youtube.com/watch?v=oNtu9P5lkkE&feature=emb_title

Table 3

Vocabulary from the video

equipment	***internship***	***part-time***	***representative***	***career fairs***
applicants	***social media***	***laptops***	***brand new***	***record***
ability	***issues***	***ambassador***	***degree***	***career service***

1. I really enjoy chemistry at Birmingham because I feel genuinely encouraged and supported through every step of my ___________. If I'm ever falling behind or struggling with something lecturers are always there to help me and ensure that I understand everything to the best of my___________.
2. As a chemistry undergraduate we do a lot of lab work. However, it's really interesting and exciting to use lots of different ___________and it helps you to understand the theory that we learn in lectures to a better degree.
3. I find it really helpful to go through my notes outside of class to sort or reinforce the knowledge that I've learnt. Birmingham has a really great service called Panopto where all of our lecturers___________ online.
4. This year the university has opened a ___________ library with great facilities and a huge range of textbooks, ___________, computers, study areas.
5. I'm a year three ___________ for chemistry and I was recently elected senior rep. Through this I have the opportunity to bring up any ___________or comments students have about the course.

6. I'm a student __________ for chemistry and today I'm helping out on one of the applicant visit days. So, I'll be taking ___________around the campus.
7. I work___________ while at university. I work for Careers Network which is the university's __________. I work for them for the engineering and physical sciences department … A sort of updating __________posts and attending __________ to tell students what kind of job opportunities and __________ opportunities there are.

***Task 4.* Compare your usual day/ week as a chemistry student at TPU with the day/ week of a chemistry student at the University of Birmingham. Write no less than 10 sentences using the vocabulary from the video.**

***Task 5.* Work with a partner. Talk about accidental discoveries or inventions in science or technology. Then discuss the latest discoveries and inventions in chemistry. Consult Table 4 to spot the difference between a discovery and an invention.**

Table 4

Discovery vs Invention

Discovery is recognizing something that already exists for the first time, that nobody has found before.
E.g. *The discovery of electricity*
Leonardo made many scientific discoveries.

Invention is creating something totally new with one's own ideas and development.
E.g. *The world changed rapidly after the invention of the phone.*

https://themaddenhouse.com/discovery-word-cloud

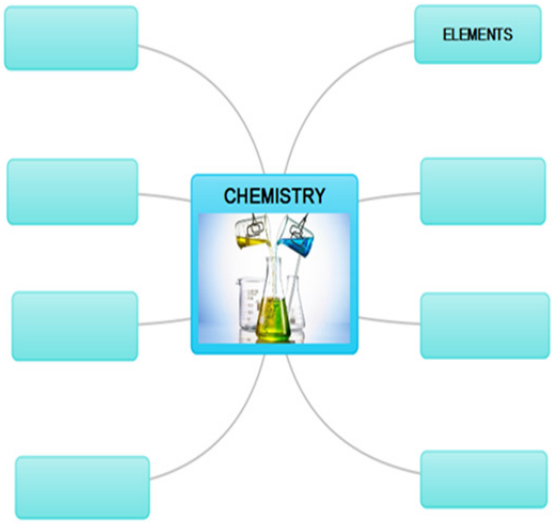
NB Although an invention is completely new to the world, the physical material needed for its production already exists, innovated from the ideas and experiences of the individual.

Task 6. **Project work. Watch the video about the University of Birmingham Campus Tour (https://www.youtube.com/channel/UC5G3iPIJk_s7El-ck-BL1wA). In a group of three to four students work on a video project featuring the facilities of National Research Tomsk Polytechnic University. In your project focus on:**

- the campus of TPU;
- sports facilities;
- the university library;
- research laboratories.

https://fgbnuac.ru/news/404.html

Task 7. **Provide examples of chemistry in your everyday life. Complete the chart with your associations for the word "Chemistry" and share with your fellow students.**



https://www.mindmaple.com

Task 8. **Read the text about chemistry as a science below. Explain the meaning of the words and phrases in blue.**

What is chemistry? All definitions of chemistry include the study of matter. Matter is defined as anything that has mass and occupies *space*. All matter is arranged or organized. The way it is arranged is called its structure. The parts of the structure and ***the ratio*** in which they are organized are called its composition. In addition, all matter has characteristics or properties. That is, each substance has a set of properties that are characteristic of that substance and give it a unique or special identity. These physical or chemical properties are the "personality traits" of that substance. In brief, chemists study the properties, the composition, and the structure of matter. They also study changes in the composition and the structure as well as the reactions of matter, especially of atomic and molecular systems.

Basically, ***chemistry is a science that deals with the composition and properties of substances and with the reactions by which substances are produced from, or converted into, other substances.***

People have practiced chemistry since ancient times.The Egyptian, Arabic, Greek, and Roman cultures each contributed significant developments to chemistry. These early developments were empirical. That is, they were achieved by trial and error and were not based on any *valid* theory of matter. The chemists (500-1600A.D.) whose practical goal was to change base metals into gold and to prolong life, also *contributed to* the development of chemistry. However, it was not until the 17th and 18th centuries that modern chemistry began to develop through systematic experimentation, called the scientific method, is usually credited with being the most important single factor in the development of chemistry and its application to technology.

Chemistry is related to physics, an other basic *branch* of science. It is also related to biology, the science of life, because life itself is basically a complicated system of interrelated chemical processes.

The range or scope of chemistry is very wide. In fact, it includes the whole universe and every animate (living) and inanimate (nonliving) thing in it. Chemistry may be broadly classified into two main branches: organic chemistry (the chemistry of living things) and inorganic chemistry (the chemistry of nonliving things). Through the study of chemistry we try to learn and understand the principles and laws that control the activity of all matter.

Chemists may try *to observe* and to explain natural situations, or phenomena, or they may invent experiments that will show the composition and structure of complex substances that are unknown in nature.

Even though the total of chemical knowledge is so *enormous* that no one could learn all of it in one's lifetime, the basic concepts are not difficult. In fact, these fundamental concepts in chemistry have become part of the education required for many professionals in a wide variety of fields and they have contributed to the rapid growth of technology.

Source: Кутенова М.М. The World of Chemistry: Английский язык для студентов-химиков. М.: Книжный дом «Университет», 2001. 272 с.

Task 9. **Work in pairs. Explain the meaning of the words from Table 5 to your fellow-student. Provide Russian equivalents for them.**

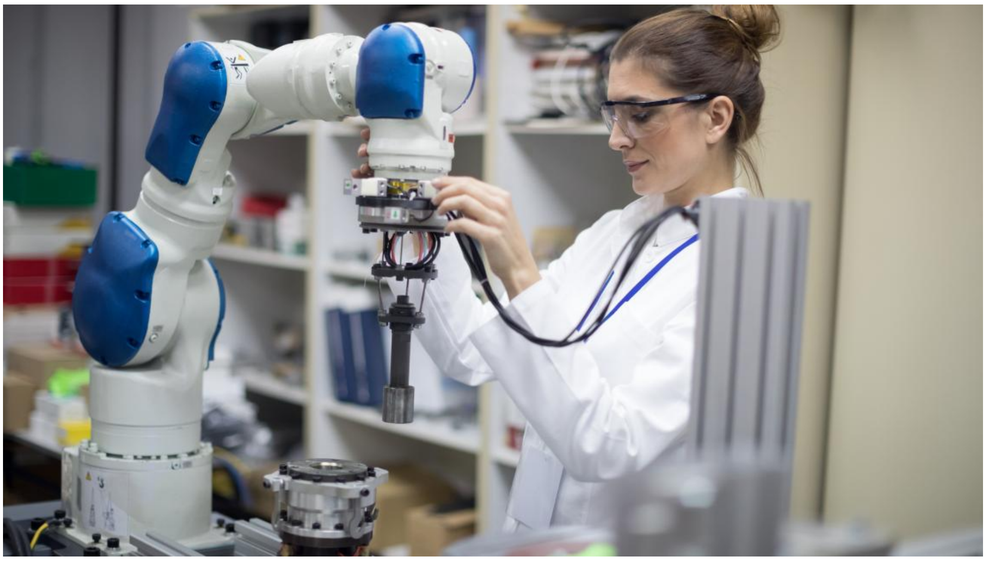
Table 5

Words for Describing Chemistry as a Science

English word	***Russian equivalent***
matter	
mass	
structure	
composition	
property	
substance	
identity	
trait	
reaction	
complicated system	
significant	
to contribute	
development	
empirical	
to achieve	
alchemist	
goal	
interrelated	
scientific method	
smth. *is related to* smth.	
guidance	
range	
scope	
to explain	
phenomenon – phenomena	
experiment	
temporary	
capacity (in this capacity)	
to consider	

Task 10. **Summarise the main ideas of the text about chemistry using the vocabulary items from Table 5.**

Task 11. **Watch the video "*What is Engineering (What do Engineers do)*" (https://www.youtube.com/watch?v=I11y_FLIEp8) and cover the questions and tasks below.**



https://www.njit.edu/academics/degree/phd-materials-science-and-engineering

1. Study the definition for "*engineering*" from the video. Watch the video and fill in the missing information.
   "***Engineering*** is a scientific field and job that involves taking our ________ __________ of the natural world and using it to invent, design, and build things to solve problems and achieve practical ________. This can include the _________ of roads, bridges, cars, planes, machines, _______, processes and computers. In other words, we can say engineering is acknowledged as a discipline that opens up opportunities and creates __________ and products that help make our lives easier".
2. It is claimed in the video that "*engineers are shaping the future*". What explanation is provided for this statement? What examples of new engineering developments can you give to illustrate it?
3. What is the origin of the word "*engineer*"? What definition is provided for this word ?
4. How has the set of engineering branches changed since the past? List the modern branches where engineers can be employed nowadays.
5. Why is the question "*What do engineers do?*" rather tricky? What is the scope of engineering jobs in the modern society?
6. It is stated that the description of the engineering work environment depends on the type of engineer. Comment on some of the work environments mentioned in the video. Which of them would appeal to you? Give your reasons.
7. What skills does one need to become an engineer?
8. What are the pros and cons of the careers in engineering?
9. Discuss the following statements with a partner:
   a) "*The world will always get more technically advanced and we'll need more engineers*";
   b) "*Science is about knowing. Engineering is about doing*".
10. Comment on some of the best engineering marvels presented in the video.

Task 12. **Watch the video "*Nuclear Engineering. A Fulfilling Career*" (https://www.youtube.com/watch?v=2h8KQq6eWGU) and cover the questions below.**

https://www.shutterstock.com/search/atom

1. What are the career options in nuclear engineering? What adjectives are used to describe these careers at the beginning of the video?
2. Are nuclear engineers in demand in the job market today? What reasons are given for this in the video?
3. What are the examples of nuclear technology being used in medicine?
4. What are the ways to solve the problem of hunger on our planet with the help of nuclear engineering?
5. Why is the field of nuclear engineering considered very prospective?

Task 13. **Identify the words from the video so that they match the Russian equivalents in Table 6.**

Table 6

Word list from the video "Nuclear Engineering. A Fulfilling Career"

English word	Russian equivalent	English word	Russian equivalent
	удовлетворение потребностей		твердые частицы
	шкала оплаты труда		ядерное деление
	способность		постоянный
	потребление		вредный, опасный
	важнейший, решающий		магнитно-резонансная томография
	спрос, потребность , требование		облегчить, смягчить
	разработка,проектирование		радиоактивный изотоп
	безопасность		истощение, опустошение
	расширяющиеся технологии		исследовать, изучать
	ископаемое		исследование
	ископаемый вид топлива		позволять, способствовать
	электростанции, работающие на ископаемом топливе		запасы
	поколение		освободить, выпустить
	влияние на		отталкивающий, репеллент

Task 14. **Read the text "Nuclear Engineering". Before you read, study the active vocabulary from Table 7 that is essential for understanding and grasping the main ideas presented in the text.**

Table 7

Word list from the text "Nuclear Engineering"

№	*English word*	*Russian equivalent*
1	nuclear engineering	ядерная инженерия
2	carbon dioxide (CO_2)	углекислый газ, CO_2
3	a cause	причина
4	coal	уголь
5	consumption	потребление
6	demand	спрос, потребность, требование
7	environmental protection	защита окружающей среды
8	expanding sorts of technology	расширяющиеся виды технологий
9	fission	деление, разделение
10	nuclear fission	ядерное деление
11	fossil	ископаемое
12	fossil fuel	ископаемое топливо
13	fossil-fuel power plant	электростанция на ископаемом топливе
14	fusion	слияние, синтез (ядер), слияние (клеток)
15	nuclear fusion	ядерный синтез
16	impact	влияние; воздействие; действие
17	natural gas	природный газ
18	nitrogen oxides (NO_X)	оксиды азота
19	nuclear reactor	ядерный реактор, атомный реактор
20	nuclear fuel	ядерное топливо
21	permanent	неизменный; долговременный; перманентный
22	petroleum	нефть, бензин
23	radiation	радиация
24	radioactive tracer	радиоизотопная метка
25	radioisotope	радиоактивный изотоп
26	safety	безопасность
27	shortage	нехватка,недостаток
28	sulphur dioxide/ sulfur dioxide (SO_2)	двуокись серы, оксид серы (IV) SO_2
29	to be in high demand	пользоваться большим спросом
30	to offer	предлагать
31	to solve	решать, разгадать
32	to turn to	обратиться (к кому-либо), переходить (к чему-либо)
33	tremendous	огромный; гигантский

NUCLEAR ENGINEERING

Nuclear engineering can be defined as the field of engineering dealing with the application of nuclear and radiation processes in technology. A significant application is the generation of electricity using nuclear reactors. Another important application is in medicine, where radiation and radioisotopes are used to diagnose, treat and prevent disease.

Nuclear energy, both from fission and fusion, offers a promising approach to meeting the energy needs – an approach that may preserve jobs, raise the standard of living of people, and alleviate the depletion of natural resources including natural gas, oil, and coal. Furthermore, nuclear energy offers the only practical, environmentally friendly approach to generating electricity on a large scale because it releases no harmful SO_2, NO_X, CO_2, or particulate matter into the atmosphere. Nuclear energy has always played an essential role in space exploration. Nuclear engineering has enabled the use of isotopic power supplies in deep space probes, and may eventually be used to design fission or fusion-based systems for more demanding space missions.

Since the discovery of fission many years ago, electricity has been produced commercially in a several hundred-billion-dollar industry. Applications of radioactive tracers have been made across multiple sectors, including medicine, science, industry, food and agriculture and transport. Radiation from particle accelerators and materials made radioactive in nuclear reactors are used worldwide to treat cancer and other diseases, to provide the power for satellite instrumentation (nuclear batteries), to improve the quality of food and increase food production, to reduce the amount of necessary fertilizers, to sterilize medical supplies, etc.

Source:https://guide.wisc.edu/undergraduate/engineering/engineering-physics/nuclear-engineering-bs/

Note the difference:

Nuclear fusion – A nuclear reaction in which atomic nuclei of low atomic number fuse to form a heavier nucleus with the release of energy.

Nuclear fission – A nuclear reaction in which a heavy nucleus splits spontaneously or on impact with another particle, with the release of energy.

https://www.epfl.ch/education/master/programs/nuclear-engineering

Task 15. **Incorporate the words and phrases from the text about nuclear engineering into your Word List. Check each other through peer dictation.**

For this, take turns to explain the meaning of the words under study so that your partner could guess them. Be precise in your explanations.

Task 16. **Work in groups of two to three students. Make the presentation on one of the topics listed below.**

Chemical engineering

Materials engineering

Nuclear engineering

Civil engineering

Mechanical engineering

Software engineering

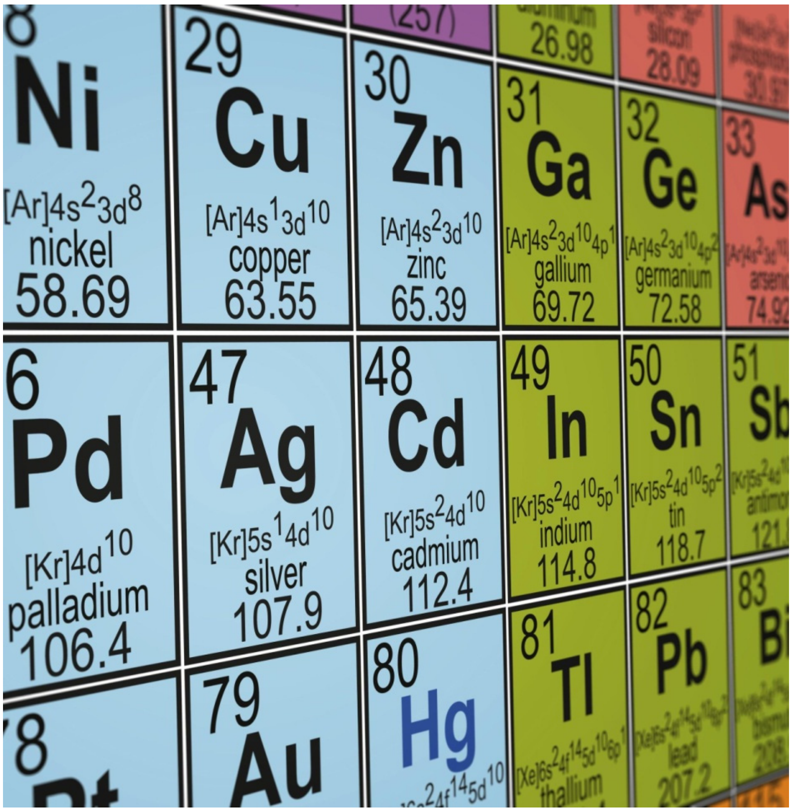
Biological engineering

Agricultural engineering

Aerospace engineering

http://drmcnatty.com/engineering-solutions

MODULE 2
EQUATIONS AND NUMBERS IN CHEMISTRY



https://ru.scribd.com/document/468980809/The-Difference-Between-an-Element-Group-and-Period

For writing, reading and explanation of chemical reactions, equations, and processes you have to know how to write and pronounce not only chemical elements, substances, etc., but also numbers, fractions and degrees.

Comment on the following quotations:

1. *"Numbers rule the universe"*. – **Pythagoras**
2. *"Numbers are intellectual witnesses that belong only to mankind"*. – **Honore de Balzac**

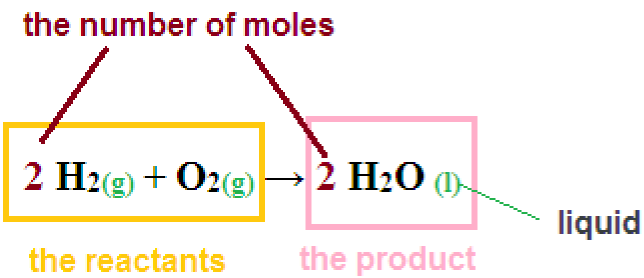
https://www.clubalfa.it/325084-tabella-unica-macrolesioni-il-mistero-dei-risarcimenti-piu-bassi

***Task 1.* Read the text and answer the questions below.**

HOW TO READ CHEMICAL EQUATIONS

Chemical reaction is a process in which one or more substances, the reactants, are converted to one or more different substances, the products. Substances are either chemical elements or compounds. A chemical reaction rearranges the constituent atoms of the reactants to create different substances as products. In reactions under normal laboratory conditions, matter is neither created nor destroyed, and elements are not transformed into other elements.

Chemical formulas and other symbols are used to indicate the starting materials, or reactants, which by convention are written on the left side of the equation, and the final compounds, or products, which are written on the right. The reactants and products are separated by an arrow, usually read aloud as "yields." Chemical equations should contain information about the state properties of products and reactants, whether aqueous (dissolved in water – aq), solid (s), liquid (l), or gas (g).



2 molecules of hydrogen react with **1 molecule** of oxygen to form **2 molecules** of water.

$$2\ NaBr + Cl_2 \rightarrow 2\ NaCl + Br_2$$

2 moles of sodium bromide react with 1 mole of chlorine to form 2 moles of sodium chloride and 1 mole of bromine.

Consistent with the law of conservation of mass, the numbers of each type of atom are the same on both sides of Equation.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

One molecule of methane reacts with two molecules of oxygen to produce one molecule of carbon dioxide and two molecules of water. The equation is balanced because the same number of atoms of each element appears on both sides of the equation (here one carbon, four hydrogen, and four oxygen atoms).

Source: https://www.britannica.com/science/chemical-reaction

1. What is a chemical reaction definition?
2. What information is contained in chemical equations?

Task 2. **To revise how to balance chemical equations watch the video "How to Balance NaBr + Cl_2 = NaCl + Br_2" (*https://www.youtube.com/watch?v=7eSBigeIoE4*).**

Task 3. **Work with a partner. Write down the reactants of a chemical equation and ask your fellow-student to write down the products to balance it and then read what they have.**

Task 4. **Read the text featuring how to write and read the names of some substances. Study some examples presented in Tables 8 and 9.**

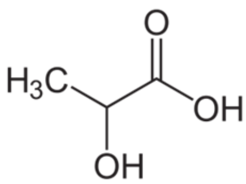
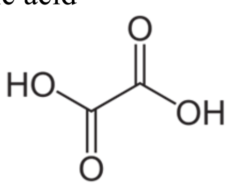
HOW TO WRITE AND READ THE NAMES OF SOME SUBSTANCES

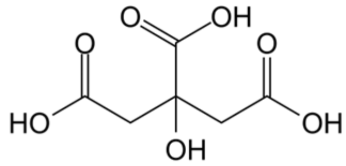
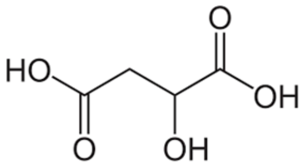
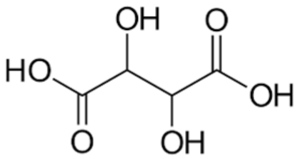
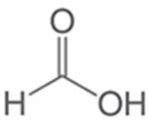
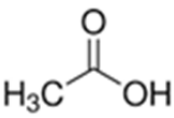
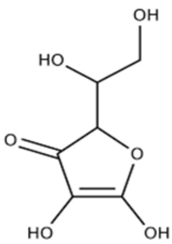
Acids are named by the anion they form when dissolved in water. Depending on what anion the hydrogen is attached to, acids will have different names.

Organic acids – acids that are naturally obtained from plants and animal sources. Some examples of organic acids are provided in Table 8.

Table 8

Examples of Organic Acids

Name of Acid	***Source***	***Photo***
Lactic acid 	Curd, milk	 https://eat-ith.com/eat-ith-events/debate-will-dairy-death-us/glassof-milk
Oxalic acid 	Spinach, tomatoes	 https://thewrightdoctor.com/2014/10/10/foods-to-enhance-detoxifcation/

Citric acid 	Oranges and lemons	 *https://www.chemicals.co.uk/blog/what-is-citric-acid*
Malic acid 	Apples	 https://foodadditives.net/acidulents/malic-acid/
Tartaric acid 	Unripe mangoes, grapes	 https://pixabay.com/photos/grapes-unripe-grapes-a-bunch-of-3537365/
Formic acid 	Ant’s sting	 https://www.pinterest.ca/pin/341499584240454991/
Acetic acid 	Vinegar	 https://www.leaf.tv/articles/what-are-the-effects-of-vinegar-on-the-skin/
Ascorbic acid 	Amla	 https://wrytin.com/ngcraftstudio/3-things-to-eat-this-winter-k3fnnd0e

Mineral acids: acids that are derived from an inorganic material or source. For example, nitric acid, hydrochloric acid and sulphuric acid.

Simple acids, known as binary acids, have only one anion and one hydrogen. These anions usually have the ending **"-ide."** As acids, these compounds are named starting with the prefix **"hydro-,"** then adding the first syllable of the anion, then the suffix **"-ic."** For example, HCl, which is hydrogen and chlorine, is called hydrochloric acid.

Table 9

Examples of Anions, Acids and their Names

Anion	*Anion name*	*Acid*	*Acid name*
Cl^-	Chloride ion	HCl	Hydrochloric acid
CO_3^{2-}	Carbonate ion	H_2CO_3	Carbonic acid
NO_2^-	Nitrite ion	HNO_2	Nitrous acid
NO_3^-	Nitrate ion	HNO_3	Nitric acid
SO_3^{2-}	Sulfite ion	H_2SO_3	Sulfurous acid
SO_4^{2-}	Sulfate ion	H_2SO_4	Sulfuric acid

Any polyatomic ion with the suffix ***"-ate"*** uses the suffix ***"-ic"*** as an acid. So, HNO_3 will be nitric acid.

When you have a polyatomic ion with one more oxygen than the ***"-ate"*** ion, then your acid will have the prefix ***"per-"*** and the suffix ***"-ic."*** For example, the chlorate ion is ClO_3^-. Therefore, $HClO_4$ is called perchloric acid.

With one fewer oxygen than the ***"-ate"*** ion, the acid will have the suffix ***"-ous."*** For example, chlorous acid is $HClO_2$.

With two fewer oxygen than the ***"-ate"*** ion, the prefix will be ***"hypo-"*** and the suffix will be ***"-ous."*** For example, instead of bromic acid, $HBrO_3$, we have hypobromous acid, HBrO.

Bases are compounds which contain oxygen or oxygen along with hydrogen. A base that contains oxygen is called an oxide while a base that contains oxygen along with hydrogen is called the Hydroxide. Substances that contain bases are called basic substances.

Naming Bases

Most strong bases contain hydroxide, a polyatomic ion. Therefore, strong bases are named following the rules for naming ionic compounds. For example, NaOH is sodium hydroxide, KOH is potassium hydroxide, and $Ca(OH)_2$ is calcium hydroxide. Weak bases made of ionic compounds are also named using the ionic naming system. For example, NH_4OH is ammonium hydroxide.

Weak bases are also sometimes molecular compounds or organic compounds because they have covalent bonds. Therefore, they are named following the rules for molecular or organic compounds. For example, methyl amine is a weak base. Some weak bases have "common" names. For example, NH_3 is called ammonia; its name isn't derived from any naming system.

Source: https://physicscatalyst.com/class-7/acid-base-salt-notes.php

***Task 5.* Discuss the following questions with your partner to make sure you have grasped the information presented in the text.**

1. How can acids, organic acids and mineral acids be defined?
2. What is the synonym for "simple acids"?
3. How are the compounds having only one anion and one hydrogen (simple acids) usually named?
4. Comment on how the names of acids containing a polyatomic ion are formed.
5. What is the difference between bases and alkalis?
6. What are the rules of naming bases?

***Task 6.* Provide 10 examples of everyday products that contain acids or bases.**

https://steemit.com/steemstem/@akeelsingh/acids-and-bases

***Task 7.* Work in groups of two to three students. Complete Table 10 writing down the corresponding mathematical symbols and providing the Russian equivalents for the words given.**

Table 10

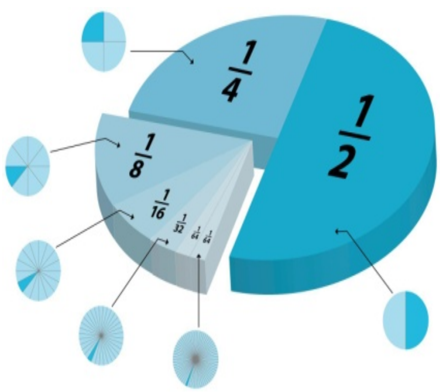
Mathematical Symbols Useful for Chemistry

Math word	***Symbol***	***Translation***	***Math word***	***Symbol***	***Translation***
fraction			quantity		
decimal			multiplies or times a times b (a x b) *a multiplied by b*		
numerator			equals *or* equal to		
denominator			does not equal *or* not equal to		
notation			less than greater than		
divided by			parenthesis [pə'renθɪsɪs]		
a divided by b			bracket		
division			a subscript n *or* a sub n		
plus or positive			minus or negative		

***Task 8.* Read the text below paying special attention to the rules of writing and saying *numbers, fractions and degrees* in English.**

FRACTION

A fraction is a part of a whole ($^3/_7$). There are two numbers to every fraction: numerator (3) and denominator (7). The top number of the fraction is called the **numerator**. The bottom number is called the **denominator**.



https://steemit.com/steemstem/@steemmaths/fraction-and-its-components-basic-mathematical-knowledge-0d207414555ac

MIXED NUMBER

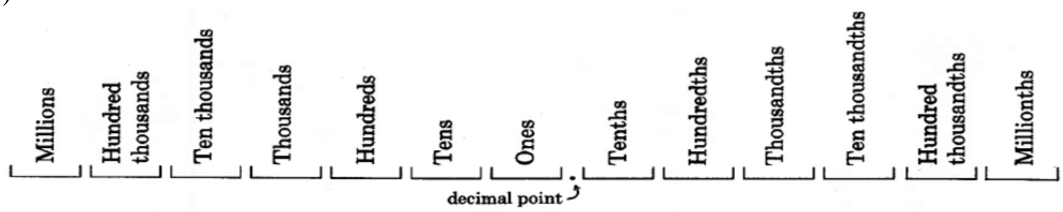
An **improper fraction** (неправильная дробь) has a numerator that is **bigger** than its denominator, for example $^{10}/_{7}$.

1 $^{3}/_{7}$ is a **mixed fraction** because it has a whole number and a fraction together.

You can use a calculator to turn a fraction into a decimal. Just divide the numerator by the denominator.

DECIMAL FRACTION

A **decimal fraction** is a fraction in which the denominator is a power of 10 (5.3; 2.6; 23.235)



https://math.libretexts.org/Bookshelves/PreAlgebra/Book%3A_Fundamentals_of_Mathematics_(Burzynski_and_Ellis)/06%3A_Decimals/6.01%3A_Reading_and_Writing_Decimals

7.9023

The **9** is in the *tenths* position.
The **0** is in the *hundredths* position.
The **2** is in the *thousandths* position.
The **3** is in the *ten thousandths* position.

Reading Decimals

1. Read the number before the decimal point.
   (If the whole number is less than 1, omit steps 1, 2).
2. Say “and” when you get to the decimal.
3. Read the number after the decimal (as if it were a whole number).
4. Say the name of the place that the decimal ends in.

https://clarkwritesblog.wordpress.com/2018/09/

1. Five and three ten**ths** – 5.30 or 5 $^{3}/_{10}$.
2. Forty-nine and one hundred**th** – 49 $^{1}/_{100}$ or 49.0100.
3. Two hundred sixteen and two hundred thirty-one thousand**ths** – 216$^{231}/_{1000}$ or 216.23100.
4. Nineteen ten thousand**ths** – 0.0019.

10^3 could be called “10 to the third power”, “10 to the power 3” or simply “10 cubed”.

10^4 could be called “10 to the fourth power”, “10 to the power 4” or “10 to the 4”.

2^{16} – “two to the sixteenth power” or “two to the power of sixteen” but that is only done in very formal speech.

The more common way to say it: two to the sixteenth.

Small numbers use **negative exponents**.

10 to the negative 10 power (10^{-10}).

10 to the negative sixth power (10^{-6}).

2.34267854E-6 is actually 2.34 times 10 to the negative sixth power ($2.34 \cdot 10^{-6}$) 2.34 times to the negative six.

Numerals

Lingographics.com

Cardinal Numbers

0	zero, oh, nil
1	one
2	two
3	three
4	four
5	five
6	six
7	seven
8	eight
9	nine
10	ten
11	eleven
12	twelve
13	thirteen
14	fourteen
15	fifteen
16	sixteen
17	seventeen
18	eighteen
19	nineteen

Ordinal Numbers

0th	zeroth (naughth)
1st	first
2nd	second
3rd	third
4th	fourth
5th	fifth
6th	sixth
7th	seventh
8th	eighth
9th	ninth
10th	tenth
11th	eleventh
12th	twelfth
13th	thirteenth
14th	fourteenth
15th	fifteenth
16th	sixteenth
17th	seventeenth
18th	eighteenth
19th	nineteenth

Large Cardinals (Short Scale)

1,000,000	10^6	a / one million
1,000,001		one million and one
2,000,000		two million
1,000,000,000	10^9	one billion
1,000,000,000,000	10^{12}	one trillion

Fractions

1/2	one half
3/2	three halves
1/3	one third
1/4	one quarter / one fourth
1/5	one fifth
3/8	three eighths

Decimals

1.125	one point one two five
0.3 or .3	zero point three *or* point three

https://www.lingographics.com/english/cardinal-ordinal-numbers/

***Task 9.* Choose one of the columns in Table 11 and present the numerals by corresponding full words of the natural language. Consult Table 12 to study some examples first.**

Table 11

Numbers for Denoting in Words

10^{-6} 10^{9} $3 \cdot 10^{17}$ 0.004 5.08 125.6 $^{3}/_{2}$ $2\ ^{8}/_{9}$ 10,000 15	10^{-10} 10^{3} $1.1 \cdot 10^{16}$ 0.014 1.08 80.7 $^{1}/_{2}$ $6\ ^{5}/_{9}$ 13 000,000 12	10^{-8} 10^{7} $3.12 \cdot 10^{16}$ 0.019 785.018 80.5 $^{1}/_{12}$ $7\ ^{3}/_{4}$ 1000 13	 *https://www.odkrywamyzakryte.com/numerologia/*

Table 12

Examples of Some Numbers Denoted in Words

10^{-7}	ten to the negative seventh power / to the negative power (of) seven
10^{8}	ten to the eight / to the eighth power/ to the power of eight
$2 \cdot 10^{12}$	two times (multiplies/multiplied by) ten to the twelfth power/ to the power (of) twelve / to the twelve
0.014	fourteen thousandths
1.78	one and seventy-eight hundredths
80.7	eighty and seven tenths
$^{8}/_{47}$	eight forty-seventh
$1\ ^{4}/_{9}$	one and four ninths
100	one/a hundred
11	eleven

Task 10. **Solutions and Concentration Units. Read the text about *solutions and concentration units.* Translate it into Russian paying special attention to the thematic vocabulary.**

CONCENTRATION UNITS

A ***solution*** can be defined as a homogeneous ***mixture*** of two or more chemical substances. If there is a solution made from a ***solid*** and a ***liquid***, we say that the solid is dissolved in the liquid and we call the solid the ***solute*** and the liquid the ***solvent***. Initially, we will consider only solutions of a solid in water. If a solution has a small amount of solute in a large amount of solvent, we say that the solution is dilute (or that we have a ***dilute solution***). If a solution has a large amount of solute for a certain amount of solvent, we say that the solution is concentrated (a ***concentrated solution***). So, as can be seen from the above provided definitions, the terms dilute and concentrated are not precise and are only used to give a rather rough indication of the amount of solute for a given amount of solvent.

https://quizizz.com/admin/quiz/5fa7abf60ce166001be2e871/concentration-of-solutions

Concentration – the amount of solute in a given amount of solvent/solution.

There are some common ways of expressing solute concentration that are usually used. Some of them:

Molar concentration (Molarity), M = moles solute/liter of solution.
Normality, N = equivalents of solute/liter of solution.
Mass percent, Wt % = (mass of solute/mass of solution) x 100 %.
Parts per million, ppm = (mass of solute/mass of solution) x 10^6.
Molality, m = moles of solute/mass of solvent.
Mole fraction, χ = moles of solute/total moles.

Molarity or molar concentration

The **molarity** of a solution *is the number of moles of the solute in 1 litre of the solution.*

Molar concentration is the amount of a solute present in one unit of a solution. Its units are mol/L or mol/m^3. Molar concentration = molarity, and can be denoted by the unit *M*.

$$\text{molarity} = \frac{\text{moles(solute)}}{\text{litres(solution)}} \qquad M = \frac{n}{V(L)}.$$

Notes: MM – molar mass; MW – molecular weight, FW – formula weight.
Number of moles of solute can be calculated by the next way:

$$n = \frac{\text{mass(g)}}{MM}.$$

If you want to find the number of moles of solute (n) if the molarity (M) and the volume in litres (V) are known, use the equation:

$$n = MV$$

a) What is the molarity of a solution of NaOH (n = 0.5 mole) in 2.5 L of solution.

Solution: $molarity = \frac{0.5 \text{ mole}}{2.5 \text{ L}} = 0.2 \text{ M}$

b) What is the molarity of a solution of NaOH (m_{NaOH} = 4 g) in 250 mL of solution.

Solution: 250 mL = 0.25 L MM of NaOH = 40.0 g/mole

$$\text{moles NaOH} = \frac{4 \text{ g}}{40.0 \text{ g/mole}} = 0.1 \text{ mole} \quad \text{molarity} = \frac{0.1 \text{ mole}}{0.25 \text{ L}} = 0.4 \text{ M}$$

***Task 11.* Work in a group of three to four students. Design a similar task of your own on molarity and ask your fellow students to complete it.**

Mass percent

The mass percent (wt %) of a solute in a solution = $\frac{mass\ of\ solute}{mass\ of\ solution} x\ 100.$

The mass of the solution is, obviously, the mass of the solute(s) plus the mass of the solvent.

a) Calculate the mass percent of NaCl in a solution of 5.50 g of NaCl in 40.0 g of water?

Solution: mass percent = $\frac{5.50 \text{ g}}{(40.0+5.50) \text{ g}} \text{x } 100 = 12.1\ \%$

b) Calculate the volume of water that is needed to dissolve 18.0 g of NaCl to make a 6 % NaCl solution?

Solution: Use 1.00 g/mL as the density of water

Volume of water = x mL; mass of water = x g

$\frac{18.0 \text{ g}}{(18.0+x) \text{ g}} \text{x } 100 = 10.0$ $\quad 1800 = 108 + 6x$

$6x = 1800 - 108 = 1692$ $\quad x = \frac{1692}{6} = 282$

Volume of water = 282 mL

Task 12. **Work in a group of three to four students. Design a similar task of your own on mass percent and ask your fellow students to complete it.**

Conversion between molarity and mass percent

$$\text{Molitary} = \frac{\text{moles(of solute)}}{\text{volume(of solution in litres)}}$$

$$\text{Mass Percent} = \frac{\text{mass of solute}}{\text{mass of solution}} \text{x } 100$$

It is clear that mass and moles of solute can be interconverted using the molar mass of the solute. Also, the mass and volume of the solution can be interconverted if the density of the **solution** is known.

Calculate the molarity of muriatic acid (a 38 % solution of HCl) whose density is 1.19 g/mL). *Solution*: Consider a definite amount of the solution; 100 g or 1 L is convenient. We will do it both ways!

1. Consider 100 g of solution; mass of HCl = 38 g

moles of HCl = 38 g x $\frac{\text{1 mole HCl}}{\text{36.45 g HCL}} = 1.04$ moles

volume of solution = 100 g x $\frac{\text{1 mL}}{\text{1.19 g}}$ x $\frac{\text{1 L}}{\text{1000 mL}} = 0.0840$ L

molarity $= \frac{\text{1.04 moles}}{\text{0.0840 L}} = 12$ M

2. Consider 1 L of solution; mass of solution = 1000 mL x 1.19 g/mL = 1190 g

mass of HCl = 1190 g solution x $\frac{\text{38 g HCl}}{\text{100 g solution}} = 452.2$ g

moles HCl = 452.2 g x $\frac{\text{1 mole HCl}}{\text{36.45 g HCl}} = 12$; moliraty $= \frac{\text{12 moles}}{\text{1 L}} = 12$ M

Dilution

Dilution can be defined as the process of decreasing the concentration of a solute in a solution. In other words, it is the process of adding a solvent to a solution. As a result, the volume of the solution becomes larger but the number of moles of the solute remains the same. Thus, the concentration of the solution decreases and the solution is said to have been diluted.

Consider, for instance, a solution of molarity M_O (molarity of the original solution) and volume V_O litres. The number of moles of solute in this solution is given by $n_O = M_OV_O$. Suppose more solvent is added to the solution and the new volume is V_D (volume of the diluted solution). The molarity of the solution will decrease to a value M_D. Since no solute has been added, the number of moles of solute remains n_O. Therefore, for the diluted solution $n_O = M_D V_D = M_O V_O$.

In the equation n = MV, Volume (V) must be in Litres. However, in the formula $M_D V_D = M_O V_O$, values (V_O) and (V_D) can be not in Liters, but they must be in the same units, for instance, in mL, m^3.

When we speak about dilute solutions, we can assume that the volume of a diluted solution is equal to the sum of the original solution volume and the volume of solvent added:

$$V_D = V_O + V_S.$$

a) Calculate the molarity of a solution made by adding 120 mL of water to 60 mL of a 3.00*M* NaOH solution.

Solution: M_O = 3.00 M x V_o = 60 mL

M_D =? V_D = (60 + 120) mL = 180 mL

$M_D V_D = M_O V_O$ M_D x 180 mL = 3.00 M x 60 mL

$M_D = \frac{3.00 \text{ x } 60}{180} = 1.0 \text{ M}$

b) Calculate the molarity of a solution made by adding 555 mL of a 0.510 *M* HCl solution to 355 mL of water.

Parts per million

The number of milligrams of solute per kg of solution = one part per million (one ppm), since 1 mg = 10^{-3} g and 1 kg = 10^3 g.

Assuming the density of water is 1.00 g/mL, 1 Liter of solution is equal to 1 kg. Following this logic: 1 mg/L is equal to1 ppm. This is generally true for dilute aqueous solutions and freshwater.

Parts per million concentrations are essentially mass ratios of solute to solution multiplied by a million (10^6). In this sense, they are similar to wt %, which could be thought of as parts per hundred.

Other variations on this theme include:

- **ppt** – parts per thousand (used for common ions in sea water);
- **ppb** – parts per billion (used for heavy metals and organics);
- **ppt** – parts per trillion (used for trace metals and trace organics);

Table 13

Common Mass Ratios for Solutions and Solids

Unit	***Solutions***		***Solids***	
ppm	mg/L	μg/mL	mg/kg	μg/g
ppb	μg/L	ng/mL	μg/kg	ng/g
ppt	ng/L	pg/mL	ng/kg	pg/g

To convert concentrations in mg/L (or ppm in dilute solution) to molarity, divide by the molar mass of the analyte to convert mass in mg into a corresponding number of moles.

Task 13. **Check your understanding. Do the necessary calculations and answer the question: *What is the molarity of a 6.2 mg/L solution of (aq)?***

To convert from molarity to mg/L (or ppm in dilute solution), multiply by the molar mass of the analyte to convert moles into corresponding number of moles.

The **<u>Maximum Acceptable Concentration</u>** (MAC) of Pb in drinking water is 10 ppb. If a sample has concentration of 55 nM, does it exceed the MAC?

Note: In seawater, 1 mg/L ≠ 1 ppm since the density of seawater is 1.03 g/mL.

Hence, 1.00 mg/Lsewater = 1.00 mg/L x 1 mL/1.03 g x 1 L/1000 mL x 1000 mg/g = = 0.971 mg/kg or 0.971 ppm.

Note: Some concentrations are expressed in terms the species actually measured e.g., mg/L of (mass of nitrate ions per liter). Or in terms of a particular element in a species that was measured. e.g., mg/L of – N (mass of nitrogen in the form nitrate ions per liter).

To convert from one to the other of these, use the molar mass ratio of the element to that of the chemical species measured. In the example above use; 14 mg N/62 mg.

It is important to clearly report unit values to avoid serious error in interpretation of results.

Task 14. **Work independently to find the values of the concentration units. Complete Table 14.**

You can use any source to look up the necessary starting values. Assume that all of the substances have unlimited solubility in water.

Table 14

Different Concentration Units for some Substances

Substance	***Mass of substance, g***	***Volume of water, mL***	***ω, %***	***C_M, mol L^{-1}***
KNO_3	10.2	437		
Na_2SO_4	32.6	230		
$FeCl_3$	27.7	217		
$BaCl_2$	30.0	390		
$CuSO_4$	4.6	549		
H_3PO_4	30.6	900		

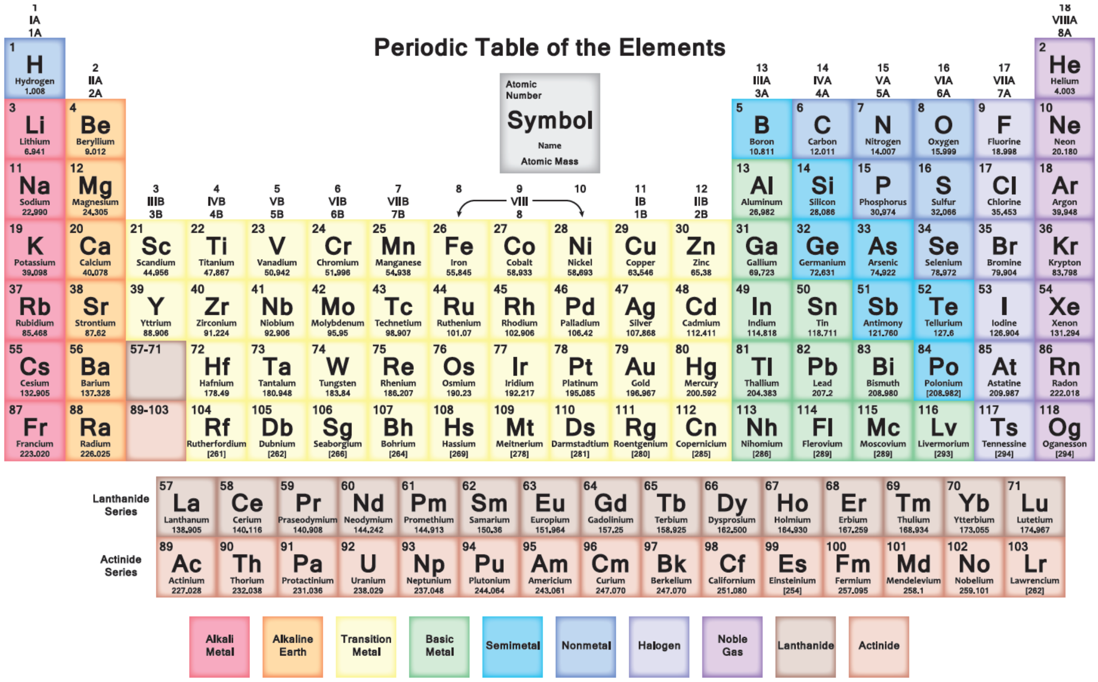
Task 15. **Incorporate the thematic vocabulary (words and phrases in bold) from the text into your Word Lists. Learn them.**

Here is an example:

Solution – раствор (в химии), решение (в математике)

Maximum Acceptable Concentration (MAC) – Предельно допустимая концентрация (ПДК)

MODULE 3
PERIODIC TABLE



https://www.pngegg.com/ru/png-ogrvo

1. Comment on the following statement.

"*What the ocean was to the child, the Periodic Table is to the chemist.*" – **Karl Barry Sharpless**.

2. Study the extract below and get ready to discuss the importance of the periodic law. Consult Table 15 for some useful language to be employed in your answer.

The periodic law of D.I. Mendeleev is a universal law of nature, the foundation of the doctrine of matter. For more than a century it has served as an inexhaustible source of scientific information, feeding both chemistry itself and many other areas of knowledge of nature. The development of the science of matter after the discovery of the Periodic Law not only did not shake its foundations, but filled it with new content, and also revealed its complexity and versatility.

Source: http://www.periodicvideos.com/

Table 15

Useful Language to Talk about the Importance of Something

• **to underline the importance of** PHRASE: (Example: The findings underlined the importance of using antibiotics only when strictly necessary. Times, Sunday Times (2014)); • **essentially** ADVERB: used for emphasizing what is the most important aspect of something or fact about something (Example: It's essentially a dictionary but it differs in one or two respects); • **the fact (of the matter) is** PHRASE: used for emphasizing what you think is the true situation or the most important point (Example: The fact of the matter is that the invention of the silicon chip was a landmark in the history of the computer); • **landmark** NOUN: You can refer to an important stage in the development of something (Example: The two books represent major landmarks in the study of growing old, and confirm the value and importance of historical and policy analysis).

Task 1. **Read the text and complete the suggested tasks.**

ABOUT ATOMS

An ***atom*** is the smallest piece of an element that maintains the identity of that element. Atoms are extremely small, they are the basic building blocks of chemistry, and it is difficult to believe that all matter is made from them. An atom includes three tiny particles called subatomic particles: electrons, protons and neutrons.

Source: Ball D.W. Introductory Chemistry – 1st Canadian Edition. Chapter 3. Atoms, Molecules, and Ions / D.W. Ball, J.A. Key [Электронный ресурс]. Режим доступа: https://opentextbc.ca/introductorychemistry/chapter/atomic-theory-2/

The modern atomic theory states that atoms of one element are the same, while atoms of different elements are different.

What makes atoms of different elements different?

Since Rutherford`s time, as physicists have learned more about atomic nuclei, the list of particles that make up nuclei has grown and continues to increase. As chemists, however, we can take a simple view of the atom because only three subatomic particles – the **proton**, **neutron**, and **electron** – have a bearing on chemical behavior.

As noted earlier, the charge of an electron is $-1.602\cdot10^{-19}$ C. That of a proton is equal in magnitude, $+1.602\cdot10^{-19}$ C. The quantity $1.602\cdot10^{-19}$ C is called the electronic charge. For convenience, the charge rather than in coulombs. Thus, the charge of the electron is 1 – and that of the proton is 1+. Neutrons are electrically neutral (which is how they received their name). Every atom an equal number of electrons and protons, so atoms have no net electrical charge.

Proton and neutrons reside in the tiny nucleus of the atom. The vast majority of an atom`s volume is the space in which the electrons reside. The electrons are attracted to the protons in the nucleus by the electrostatic force the exists between particles of opposite electrical charge.

Source: Chemistry: The Central Science / T.E. Brown, H.E. LeMay, B.E. Bursten, et al. 13th ed. Prentice Hall, 2014. 1248 p.

***Task 2.* Tell about atomic structure using appropriately the suggested vocabulary items from Table 16.**

Table 16

Vocabulary Useful for Talking about Atoms and Describing Atomic Structure

English word	***Russian equivalent***
attract	притягиваться
distinguish	различить, распознать
indivisible	неделимый
landmark	важный
measure	мера
obtain	получить
particles	частицы
surface	поверхность
to accelerate	ускорять
voltage	напряжение
features	отличительные способности
evidence	доказательства
magnitude	величина
electrically neutral	электрически нейтральный

Task 3. **Work in groups to solve the problems.**

A) The diameter of a Russian ruble is 20.5 mm, and the diameter of a silver atom is 2.88 Å. How many silver atoms could be arranged side by side across the diameter of a ruble?

B) The diameter of a carbon atom is 154 Picometers. Express this diameter in Nanometers, Angstroms.

Task 4. **Watch the video "A Simple Guide to the Periodic Table"** (https://www.youtube.com/watch?time_continue=1&v=Tb6Zrl2REIY&feature=emb_log).

A) Study the vocabulary from the video (Table 17).

Table 17

Vocabulary from the Video "A Simple Guide to the Periodic Table"

English word	***Russian equivalent***	***English word***	***Russian equivalent***
to unravel	объяснять; распутывать	**flammability**	воспламеняемость
complexity	сложность; запутанность	**to catch on fire**	загореться
to compare	сравнивать	**poisonous**	ядовитый
pattern(s)	принципы, уклад	**heat of combustion**	теплота сгорания
grid	решётка; сетка;	**alkali metal**	щелочной металл
row	ряд	**alkaline Earth Metals**	щелочноземельные металлы
column	колонка/колонна	**transition Metals**	переходные металлы
randomly	случайно	**metalloids**	металлоиды
to arrange	приводить в порядок; классифицировать	**other metals**	другие металлы
periodic symbol	символ обозначения в периодической таблице	**nonmetals**	неметаллы
subsequent	последующий	**halogens**	галогены
to lowercase	писать строчными буквами, нижний регистр; мелкий шрифт	**noble gases / inert gases**	благородные газы / инертные газы
to recognize	узнавать, распознавать	**pale**	бледный
extensive	обширный	**malleable**	тягучий,ковкий, податливый
to distinguish	отличать, различать	**ductile**	пластичный
to propose	предлагать; вносить предложение	**conductor**	проводник
remotely	удаленно	**melting point**	точка плавления

to recur	повторяться, возвращаться; снова возникать;	**boiling point**	точка кипения
in the order	в порядке	**to occur**	происходить, встречаться
group	группа	**freely**	свободно
period	период	**to tarnish**	тускнеть, окисляться
familiar	близкий, понятный	**harder**	более твердый
to establish	образовать; устанавливать	**Earth's crust**	земная кора
to alter	изменять, менять	**moderately (reactive)**	умеренно; средне
luster	блеск	**distinctive**	характерный, отличительный
odor	запах	**flame**	огонь
Rare Earth Elements	редкоземельные элементы	**silver bluish**	серебристый, голубоватый
wire	проволока; провод	**brittle**	ломкий
ductility	эластичность, тягучесть	**brittleness**	хрупкость
to bent **bent** (прилаг)	вмять, согнуть согнутый, изогнутый	**opaque**	непрозрачность; светонепроницаемост ь
malleability	тягучесть, ковкость	**brittle solids**	хрупкие твердые тела
to determine	определять	**vapour**	пар

B) Fill in the gaps with a suitable word or phrase.

1. The elements are organized in a big _____ containing _____ and _____.
2. They are collectively called _____ _____.
3. Examples of chemical propeties are: _____ (the ability to _____ _____ _____) and toxicity (the ability to be _____).
4. Other chemical properties are radioactivity and its _____ _____ ______.
5. _____ ______ are so soft, that they can be cut with a knife. They are _____, _____and are good _____ of heat and electricity. they have low _____ and _____ points compared to most other metals.
6. Elements classified as _____ _____ are very reactive metals that do not _____ freely in nature.
7. The alkaline _____ metals are shiny silver white colored solid metals that are seen to _____ in air.
8. They are soft metals although they are _____ and denser than the _____ metals.
9. Elements classified as alkaline earth metals are all found in the _____ _____, but not in the element form as they are _____ reactive with other substances instead
10. Alkaline earth metals all burn in air and glow with characteristic colors when heated. Their _____ flames and colors explain why they are used in fireworks.
11. Only a few of the transition metals are coloured; most of them are silver gray or _____ _____.
12. The terms _____, semi-conductivity and metallic _____ are often used as distinguishing indicators of _____ status.

13. Other metals are solid, ______, ductile and ______.
14. Halogens are ______ elements with low ______ and ______ point. They have colored ______ and are poor ______ of heat and electricity.

C) Answer the questions.

1. Why is the Periodic Law considered the basis for the Natural System of Elements?
2. What is the modern wording for the Periodic Law?
3. What is the reason for periodic dependence of the properties of elements and their compounds upon the charge of an atomic nucleus?

Task 5. **Read the text about alkali metals and answer the questions. Explain in English the meaning of the highlighted words and phrases. Consult a dictionary if necessary.**

THE ALKALI METALS

The alkali metals are soft metallic solids. All have characteristic metallic properties, such as silvery, metallic luster, and high thermal and electrical conductivity. The name alkali comes from an Arabic word meaning "*ashes*." Many compounds of sodium and potassium, two alkali metals, were isolated from wood ashes by early chemists.

Table 18

Properties of Alkali Metals

Atomic number	***Element***	***Chemical Symbol***	***Outer electron configuration***	***Melting point, C^0***	***Density (g/cm^3)***	***Atomic radius (nm)***
3	Lithium	Li	$2s^1$	181	0.53	0.157
11	Sodium	Na	$3s^1$	98	0.97	0.191
19	Potassium	K	$4s^1$	64	0.86	0.236
27	Rubidium	Rb	$5s^1$	38	1.53	0.253
55	Cesium	Cs	$6s^1$	28	1.88	0.274
87	Francium	Fr	$7s^1$	-	-	-

What conclusions about the properties of alkali metals can be drawn from the data presented in the table?

As **Table 18** shows, the alkali metals have low densities and melting points, and these properties vary in a fairly regular way with increasing atomic number. We see the usual trends as we move down the group, such as increasing atomic radius and decreasing first ionization energy. Outer s electron of the alkali metal can be removed easily. As a result, the alkali metals are all very reactive, readily losing one electron to form ions carrying a 1+ charge.

In nature the alkali metals exist only as compounds. Sodium and potassium are relatively abundant in Earth's crust, in seawater, and in biological systems. Sodium and Potassium are relatively abundant in Earth's crust, in seawater, and in biological systems. They are presented always as the cations of ionic compounds. All alkali metals react directly with most nonmetals. A reaction of the alkali metals with water is a violent chemical reaction, producing hydrogen gas and a solution of an alkali metal hydroxide. If you put sodium in water, it will melt and begin to move rapidly over the surface of the water. In this reaction an alkali is formed – sodium hydroxide.

$$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$$

Potassium must be handled with great care. It can ignite spontaneously when exposed to air. Potassium reacts so vigorously with water that the hydrogen released in the reaction ignites.

In many cases, enough heat is generated to ignite the H_2, producing a fire or sometimes even an explosion, as in the case of K reacting with water. The reaction is even more violent for Rb and, especially, Cs, because their ionization energies are even lower than that of K.

Recall that the most common ion of oxygen is the oxide ion, O^{2-}. We would therefore expect that the reaction of an alkali metal with oxygen would produce the corresponding metal oxide. Indeed, reaction of Li metal with oxygen does form lithium oxide:

$$4Li_{(s)} + O_{2(g)} \rightarrow 2Li_2O_{(s)}$$

When dissolved in water, Li_2O and other soluble metal oxides form hydroxide ions from the reaction of O_2^- ions with H_2O.

The reactions of the other alkali metals with oxygen are more complex than we would anticipate. For example, when sodium reacts with oxygen, the main product is sodium peroxide, which contains the – ion:

$$2Na_{(s)} + O_{2(g)} \rightarrow Na_2O_{2\,(s)}$$

Potassium, rubidium, and cesium react with oxygen to form compounds that contain the O^{2-} ion, which we call the superoxide ion. For example, potassium forms potassium superoxide, KO_2:

$$K_{(s)} + O_{2\,(g)} \rightarrow KO_{2\,(s)}$$

The alkali metals are extremely reactive toward water and oxygen. Because of this reactivity, the metals are usually stored submerged in a liquid hydrocarbon, such as mineral oil or kerosene.

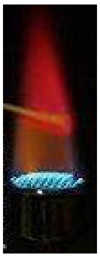
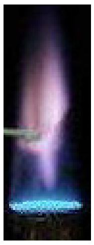
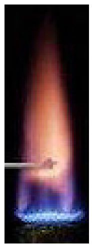
Although alkali metal ions are colorless, each emits a characteristic color when placed in a flame.

https://www.franklychemistry.co.uk/group_1.html

What alkali metals can be considered most abundant/ rare?

Task 6. **Match the element with its characteristic color and a picture.**

(a) Lithium	**(b)** Sodium	**(c)** Potassium	**(d)** Rubidium	**(e)** Cesium
(1) Reddish violet	**(2)** Crimson red	**(3)** Lilac	**(4)** Yellow	**(5)** Blue

(I)  **(II)**  **(III)**  **(IV)**  **(V)** 

https://www.seilnacht.com/Chemie/ch_licl.htm

The ions are reduced to gaseous metal atoms in the flame. The high temperature excites the valence electron from the ground state to a higher-energy orbital, causing the atom to be in an excited state. The atom then emits energy in the form of visible light as the electron falls back into the lower-energy orbital and the atom returns to its ground state. The light emitted is at a specific wavelength for each element.

Task 7. **Watch the video about the alkali metals (https://www.youtube.com/watch?v=JAPWCJEo9Iw) and complete the task below. Before watching, study the suggested vocabulary items in Table 19.**

Table 19

Vocabulary from the Video about the Alkali Metals

outermost energy level – внешний электронный уровень	to be stored under oil – хранится под маслом
unfilled outer electron shell – незаполненная внешняя электронная оболочка	to be handled – быть обработанным
to accommodate – размещать	to be handled with care – быть обработанным с осторожностью
subscript – нижний индекс	to tarnish – тускнеть
notation – обозначение	to discolour – обесцветить
naturally abundant – естественно в изобилии	to float – держаться на плаву
abundant – изобильный,	to fizz – шипеть
	to skate – кататься
	evidence – доказательство

распространенный	to lit – светится
the longest-lived isotope – самый долгоживущий изотоп	splint – щепа
	squeaky – скрипучий
critical point – критическая точка	pop – хлопок
	solution is alkaline – раствор щелочной
sublimation – сублимация	to behave – вести себя
specific heat – удельная теплоемкость	to ignite – зажечь
upon descending – по убыванию	to ignite on its own – самовозгораться
core electrons – электрон внутренней оболочки; внутренний электрон	vigorous ['vɪg(ə)rəs] – энергичный, активный
to precipitate – осаждать	
ether – эфир	
in descending order – в порядке убывания	

Task 8. **Write a review about an alkali metal describing its properties. Present the information to your fellow-students, but DO NOT say the name of the element, make you fellow-students guess it.**

Task 9. **Read the text about the alkaline earth metals and complete the task below.**

ALKALINE EARTH METALS

Like the alkali metals, the alkaline earth metals are all solids at room temperature and have typical metallic properties.

Table 20

Properties of the Alkaline Earth Metals

Atomic number	***Element***	***Chemical symbol***	***Outer electron configuration***	***Melting point, C^0***	***Density (g/cm^3)***	***Atomic radius (nm)***
4	Beryllium	Be	$2s^2$	1283	1.86	0.133
11	Magnesium	Mg	$3s^2$	649	1.74	0.16
19	Calcium	Ca	$4s^2$	850	1.54	0.2
27	Strontium	Sr	$5s^2$	770	2.67	0.213
55	Barium	Ba	$6s^2$	710	3.61	0.25

Compared with the alkali metals, the alkaline earth metals are harder and denser, and melt at higher temperatures. The first ionization energies of the alkaline earth metals are low but not as low as those of the alkali metals. Consequently, the alkaline earth metals are less reactive than their alkali metal neighbors. You know that the ease with which the elements lose electrons decreases as we move across a period and increases as we move down a group. Thus, beryllium and magnesium, the lightest alkaline earth metals, are the least reactive.

The trend of increasing reactivity within the group is shown by the way the alkaline earth metals behave in the presence of water. Beryllium does not react with either water or steam, even when heated red-hot. Magnesium reacts slowly with liquid water.

Calcium and the elements below it react readily with water at room temperature.

$$Ca_{(s)} + 2H_2O_{(l)} \rightarrow Ca(OH)_{2(aq)} + H_{2\,(g)}$$

Alkaline earth elements tend to lose their two outer s electrons and form 2^+ ions. For example, magnesium reacts with chlorine at room temperature to form $MgCl_2$ and burns with dazzling brilliance in air to give MgO.

Source: Chemistry: The central science / T.E. Brown, H.E. LeMay, B.E. Bursten, et al. 14th ed. Pearson Education Limited, 2017. 1248 p.

1. Write the reactions for **$Mg(s) + Cl_2(g)$** and **$Mg(s) + O_2(g)$**.
2. Compare the alkali metals and the alkaline earth metals.

Task 10. **Watch the video "The Alkaline Earth Metals" (https://www.youtube.com/watch?v=T7K4Qi5PiFg) and complete the sentences.**

1. They are ______________ that readily give up electrons to other substances.
2. The element ______________ can ______________ large amounts of heat which makes it useful for spacecraft and aircraft construction.
3. ______________ is a light metal.
4. ______________ is an ______________ element for countless living organisms.

5. ____________________ goes into colorful flares and fireworks and __________________ paints.
6. A __________ version of this element is one of the most deadly ________ of _______ ________.
7. _________ is a heavy silver metal that is used in spark-plugs, ________ _________ and fluorescent lamps.
8. _______ is an intensely radioactive element that doctors once often used to __________ cancer cells.
9. In their _________ forms the alkaline earth metals are shiny silvery grey metals. They have relatively high _________ and _________ ___________ and they are good ______________ of heat and electricity.
10. The alkaline earth metals are so reactive because they are __________ _____________________.

***Task 11.* Write 6–8 sentences about alkaline earth metals. Tell about their properties. Cite some examples of everyday uses of alkaline earth metals.**

***Task 12.* Read the text about chalcogens. Get ready to comment on their chemical properties making use of the topical vocabulary presented in the table below.**

CHALCOGENS

About the Group

Group 16 is the oxygen family. It consists of the elements *oxygen, sulfur, selenium, tellurium, and polonium*. Each has six of the desired eight electrons required for the octet in its highest energy level. This means that it takes or accepts two electrons from atoms of other elements to form anions or shares two electrons to form covalent bonds.

Chemical Properties

Oxygen and sulfur are common elements. In fact, oxygen is the most common element (by mass) in the earth's crust. Because oxygen is second in electronegativity only to fluorine, it reacts with almost everything to form compounds here on earth. Selenium has some semimetal characteristics, such as an increase in electrical conductivity when a light is shined on it. Tellurium is a true semimetal, existing in compound with both positive and negative charges. Polonium is an extremely rare radioactive element discovered by Marie Curie and named for her native Poland. This means that the oxygen family is split between nonmetals and semimetals.

Source: Chemical properties of oxygen. Health effects of oxygen. Environmental effects of oxygen [Электронный ресурс]. Режим доступа: https://www.lenntech.com/periodic/elements/o.htm

Table 21

Vocabulary from the Text about Chalcogens

№	*English word*	*Russian equivalent*
1	Oxygen	кислород
2	Sulphur	сера
3	Selenium	селен
4	Tellurium	теллур
5	Polonium	полоний
6	oxidation state	степень окисления, валентность, отвечающая степени окисления
7	chalcogens	халькогены
8	rust (сущ.) to rust (глагол)	ржавчина ржаветь, покрываться ржавчиной
9	decomposition	разложение
10	thickness	толщина
11	electron affinity affinity	сродство к электрону сродство
12	pungent	едкий; резкий; острый; жгучий
13	gunpowder	порох
14	source	источник
15	surface (сущ)	поверхность
16	Earth crust	земная кора
17	significant	важный
18	acid rain	кислотный дождь
19	impurity	примесь
20	ore	руда
21	rubber	резина; каучук

Task 13. **Choose an element from the Oxygen Family presented in Table 22. Watch the video about it and retell the main ideas from the video to your fellow-students. Dwell on the description of the properties of the chosen element and some experiments demonstrated in the video.**

Table 22

Links to the Video about Chalcogens

Element	*Link to the Video*
Oxygen	http://www.periodicvideos.com/videos/008.htm
Sulphur	http://www.periodicvideos.com/videos/016.htm
Selenium	http://www.periodicvideos.com/videos/034.htm
Tellurium	http://www.periodicvideos.com/videos/052.htm
Polonium	http://www.periodicvideos.com/videos/084.htm

What do you know about number 116 on the periodic table?
What is its name, symbol? What are the properties and uses?

***Task 14.* Watch the video "The Smelliest Element – Livermorium" (http://www.periodicvideos.com/videos/116.htm).**

Decide whether the following statements are true or false?

1. Livermorium was created by scientists at the Joint Institute for Nuclear Research in Dubna, Russia, in 2000. On December 6 of that year, it was jointly announced by the Russian scientists and scientists at the Lawrence Livermore National Laboratory.
2. Livermorium occurs naturally on the earth, it is a member of Thorium series.
3. Previously, it was known as Ununhexium – one-one-six in Latin.
4. Livermorium has four isotopes with known half-lives, all of which decay through alpha decay. The most stable is ^{293}Lv with a half-life of about 53 milliseconds.
5. Atomic Number: 116; Atomic Symbol: Lv; Atomic Weight: [293]; Melting Point: 1120 K Boiling Point: 687 K.

***Task 15.* Read the text about the halogens and render it into Russian. Answer the questions after the text.**

THE HALOGENS:
Fluorine, Chlorine, Bromine, Iodine, and Astatine

With the exception of He, Ne, and Ar, all of the elements in the periodic table form halides. Ionic or covalent halides are among the most important and common compounds. They are often the easiest to prepare and are widely used as source materials for the synthesis of other compounds. Where an element has more than one valence, the halides are often the best known and most accessible compounds in all of the oxidation states. There is also an extensive and varied chemistry of organic halogen compounds; the fluorine compounds, especially where F completely replaces H, have unique properties. The element *astatine,* named for the Greek for "unstable," has no stable isotope. As far as can be ascertained by tracer studies, At behaves like I, but is perhaps somewhat less electronegative.

Properties of the Elements

Fluorine was first isolated in 1886 by H. Moissan. It is the most chemically reactive of all the elements and combines directly (often with extreme vigor), at ordinary or elevated temperatures, with all the elements other than He, Ne, and Kr. It also attacks many other compounds, breaking them down to fluorides; organic materials often inflame and burn in F_2.

The great reactivity of F_2 is in part attributable to the low dissociation energy of the F-F bond, and because reactions of atomic fluorine are strongly exothermic. The low F-F bond energy is probably due to repulsion between nonbonding electrons. A similar effect may account for the low bond energies in H_20_2 and N_2H_4.

Chlorine is obtained by electrolysis of brine. It is a greenish gas. It is moderately soluble in water.

Bromine occurs in much smaller amounts, as bromides, along with chlorides. Bromine is a dense, mobile, dark red liquid at room temperature. It is moderately soluble in water and miscible with nonpolar solvents.

Iodine is a black solid with a slight metallic luster. At atmospheric pressure it sublimes without melting. It is readily soluble in nonpolar solvents such as CS_2 and CCI_4 . Such solutions are purple, as is the vapor. In polar solvents, unsaturated hydrocarbons, and liquid $S0_2$ brown or pinkish-brown solutions are formed. Iodine forms a blue complex with starch, in which the iodine forms linear I-5 ions in channels in the polysaccharide amylose.

Astatine has been identified as a short-lived product in the natural radioactive decay series of uranium and thorium. About 20 isotopes of astatine are known, but the longest lived has a half-life of only 8.3 h. As a result, macroscopic quantities cannot normally be isolated for synthetic purposes, although a few inorganic compounds (HAt, CH_3At, AtI, AtBr, and AtCI) have been detected by mass spectrometry. Astatine appears to behave chemically about as would be expected on extrapolation of the properties of the other halogens. It is rather volatile and somewhat soluble in water. A few organic compounds, such as C_6H_5At, $C_6H_5AtCI_2$,and $C_6H_5AtO_2$are known.

Answer the questions:

1. *What is the reactivity of halogens? Refer to the Periodic Table to answer the question.*
2. *How many electron shells are there in an atom of bromine?*
3. *What radioactive element is there in group 17? What is its half-life?*
   How many valence electrons do halogens have? How many electrons do they need for completing a valence shell?

***Task 16.* Read the text about the noble gases. Learn the new words from the text presented in Table 23.**

THE CHEMISTRY OF THE NOBLE GASES

Group 0 or 8 of the periodic table contains the **Noble gases**: helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe) and radon (Rn). This group was the last of the periodic table to be discovered due to their unreactivity.

Table 23

Vocabulary from the text about Noble Gases

English word	***Russian equivalent***	***English word***	***Russian equivalent***
noble gases / inert gases	благородные газы/ инертные газы	**award**	премия, награда
argon	аргон	**incredibly**	невероятно, чрезвычайно
helium	гелий	**behaviour**	поведение; поступки; манеры; отношение
neon	неон	**attempt**	попытка
krypton	криптон	**to hold**	держать
xenon	ксенон	**speculate**	размышлять, спекулировать
fractional distillation	фракционная перегонка; дробная перегонка	**in spite of**	несмотря на
distinctive	отличительный, характерный	**spite**	злоба; злость; озлобленность; враждебность; неприязнь;
glow **to glow**	свечение (сущ) светиться (гл)	**to remain**	оставаться
gain or loss of electrons	присоединять или отдавать электроны	**to revert**	возвращаться, переходить назад
fluorine	фтор	**eminent**	выдающийся, именитый
tetrafluoride	тетрафторид	**argon fluorohydride / argon hydrofluoride**	Гидрофторид аргона HArF
difluoride	дифторид	**caesium iodide**	йодид цезия CsI
fluoride	фторид	**prestigious**	престижный

The periodic table had not allowed for a group of elements between the halogens and the alkali metals so their discovery came as a complete surprise. The first to be found was argon, in 1895 by William Ramsay and Lord Rayleigh. This was so unexpected that it was suggested by a number of eminent scientists, including Mendeleev, that it was a new sort of nitrogen, N3. Within three years, Ramsay and his co-workers had also found helium, neon, krypton and xenon by using fractional distillation to separate out liquid air into several components. They showed that these gases are monatomic (consist of only one atom) and unreactive. Ramsay and Lord Rayleigh were both awarded Nobel prizes for their discoveries.

In 1913, Rutherford and Bohr published their theories on the structure of the atom and electronic configurations. We still use these theories today to explain the chemical properties of elements. It was noted early on that the noble gases were especially stable and this was linked to their electron configurations. Chemical properties of other atoms were related to the gain or loss of electrons from the configuration of the nearest monatomic gas. These theories were incredibly successful in predicting and explaining patterns of chemical behaviour. But partly as a result of them, the noble gases came to be thought of as completely inert and unreactive – chemists *William Ramsay* thought that they could *not* react.

Changing ideas

However, even as early as 1916, it was noted that xenon was the most likely to chemically combine and that it would probably be with fluorine or oxygen. A few attempts were made to react xenon and fluorine, but without success. Chemists generally held that all noble gases were completely inert to chemical combination.

That changed when a chemist called Neil Bartlett, who was originally from England but was working in Canada, tried something different. He had been working on compounds of platinum and fluorine and speculated that these may be reactive enough to combine with xenon. He was right. In 1962 he announced that he had made the first compound of xenon – with platinum and fluorine. Its chemical formula was complex and he had probably made a mixture rather than a pure compound – but he had offered the first proof that compounds could be prepared from a noble gas. Since he showed that it could be done, more than 100 compounds of xenon have been prepared including oxides, acids and salts. Even compounds with xenon bonded to hydrogen, sulfur and gold have been made, although most are stable only at very low temperatures.

Following Neil Bartlett's success, other compounds of noble gases followed; radon fluoride in 1962 and krypton difluoride in 1963. In spite of the success in forming compounds of three of the noble gases, opinion remained among chemists that the other gases were inert and would not form compounds. It took until 2000 before the first compound of argon was announced. It has the formula HArF and is called argon fluorohydride. It was made by a team of Finnish chemists by freezing a mixture of argon and hydrogen fluoride onto caesium iodide at -265˚C and exposing the mixture to UV radiation. They clearly identified the new compound and showed that the argon had formed bonds, but on warming it reverts back to argon and hydrogen fluoride.

Source: Wong V. The Chemistry of the Noble Gases / V. Wong // Catalyst, 2011. P. 4–5. [Электронный ресурс]. Режим достпуна: https://www.stem.org.uk/system/files/elibrary-resources/legacy_files_migrated/8436-catalyst_21_3_475.pdf

Task 17. **Read the text about nitrogen, carbon and boron families. Study the vocabulary from the text (Table 24) and fill in the gaps with the missing information.**

Families: Nitrogen, Carbon and Boron

Table 24

Vocabulary from the Text about Nitrogen, Carbon and Boron Families

English word	***Russian equivalent***	***English word***	***Russian equivalent***
nitrogen family	азотное семейство	**brittleness**	хрупкость
nitrogen	азот	**saltpeter**	селитра
phosphorus	фосфор	**fertilizer**	удобрение
arsenic	мышьяк	**explosive**	взрывчатое вещество
antimony	сурьма	**combustion**	горение
bismuth	висмут	**solder**	спайка; припой; слияние
phosphoric acid	фосфорная кислота	**upset stomach**	несварение желудка, расстройство желудка
carbon family	углеродная семья	**expand**	расширять; развивать; распространять
carbon	углерод	**plumbing**	водопровод
silicon	кремний		
germanium	германий	**to prevent**	предотвращать; предупреждать; предохранять
tin	олово		
lead	свинец	**cooking utensils**	кухонная посуда; кухонная утварь
Silicon dioxide, SiO_2,	диоксид кремния	**onto**	на
boron	бор	**wipe**	стирание; удаление
aluminum	алюминий	**peculiar (прил)**	особенный
gallium	галлий		
indium	индий		
thallium	таллий		
borax	бура (декагидрат тетрабората натрия).	**squealing**	визг, скрип
boric acid	борная кислота	**to bent**	гнуть
gallium arsenide	арсенид галлия	**snap**	треск
infrared filter	ИК-фильтр	**crunch**	хруст, скрип

In the passages below fill in the gaps with the missing information.

About the Group N______

The Group ____________ elements are generally known as the ____________ *family*.

All of the elements of this family have five electrons in their outermost energy level.

This group is divided into nonmetals, semimetals, and metals by characteristic.

The top two elements, ____________ and ____________, are very definitely nonmetals, forming –3 charge anions.

____________ is a diatomic gas and ____________ is a solid. The elements ____________, ____________ and ____________ all have some characteristics of semimetals such as brittleness as a free element.

____________ is the only true semimetal of the three, existing in compounds with both –3 or +5 charges.

____________ and ____________ can exist with a –3 charge in compound but are more commonly found as metals with a +5 charge because of their size. The pull of the positive protons found in their nucleus is so far from the outer shell (highest energy level) that the outer energy level electrons are more easily stripped off than they are able to attract three more electrons to complete the octet. In fact, ____________ is generally classified as a metal.

Chemical Properties

____________ is used in saltpeter for fertilizer and explosives. It is also useful to create an oxygen-free atmosphere to prevent oxidation or combustion. A common use for liquid ____________ today is the rapid freezing of food products. We also use liquid ____________ in medical/surgical applications such as cryotherapy and cryosurgery.

____________ is used in compounds such as ____________ acid, to make synthetic fertilizers, and in detergents.

____________ and ____________ are most commonly found in alloys used for the production of batteries and special types of solder.

____________ is commonly used for alloys of metals and as a component of cosmetics or medicine used to treat upset stomach (Pepto-Bismol) and eczema.

About the Group N ______

Group ____________ is the ____________ *family*. The five members are ____________, ____________, ____________, ____________, and ____________. All of these elements have four electrons in their outermost energy level. Of the Group ___ elements, only ____________ and ____________ form bonds as nonmetals (sharing electrons covalently). ___________ and *germanium* are semimetals (metalloids), existing in compounds with either +4 or –4 charges. ___________ and ___________ are definitely metals. They always lose electrons due to the distance of their outer shells from the nucleus. They usually form compounds as cations with a +4 charge. All of the elements of this family can form four bonds, the most of any family.

Chemical Properties

The element ___________ is the basis of life. It is found in all living material. ___________ is a semiconductor used commonly in computer chips and solar cells. It is also the second most abundant element in the earth's crust. ___________ ___________, ___________, is the major component of glass. ___________ has important semiconductor properties and is used in the computer industry. It is one of the few elements that expand when frozen. ___________ has long been used for plumbing and is also used to block radiation. ___________ was once used to make cans because it is relatively stable – unreactive. ___________ has replaced the more expensive ___________ today.

About the Group N ______

The last of the p block families we will be looking at is the ___________ *family* – Group ___. This group includes the elements ___________, ___________, ___________, ___________, and ___________. All five have three electrons in their outer energy level. Only one member of this family is a metalloid – ___________. The others are classified as metals, forming positive ions by giving up their three outermost electrons.

___________ is most commonly found as ___________ and ___________ ___________, which are used in cleaning compounds. ___________ is the third most common element in the earth's crust. It is used as a coating agent, to prevent oxidation. It is an excellent conductor of electricity and heat and can be found in many cooking utensils. ___________ is important today in the production of ___________ ___________ and laser diodes. ___________ is a very soft metal that can actually be wiped onto other metals as an anticorrosion agent. It also has the peculiar quality of squealing when bent. Finally, ___________ is quite toxic and is sometimes used in rat poisons. It has also been used in glass to make special infrared filters.

Task 18. **Read the two extracts about rare earth elements. Render them into Russian.**

RARE EARTH ELEMENTS

Extract 1. The elements classified as "Rare Earth Elements" (REEs) are located in Group 3 of the Periodic Table and in the 6th and 7th periods. The Rare Earth Elements are of the Lanthanide and Actinide series. Most of the elements in the Actinide series are synthetic or man-made.

Source: The Periodic Table [Электронный ресурс]. Режим доступа: http://www.elementalmatter.info/

Extract 2. A passage from a **"A review on the recovery and separation of rare earths and transition metals from secondary resources"** by Nilam Swain, Sujata Mishra.

REEs comprise 17 elements i.e. **yttrium**, **scandium** and 15 **lanthanides**. REEs are divided into two categories as lighter rare earth elements (LREE) and heavier rare earth elements (HREE) on the basis of their electronic configuration. Total **abundance** of rare earth elements in earth's crust is 169 ppm. The crustal abundance of HREEs (i.e.31.34 ppm) is lower as compared to LREEs which is about 137.8 ppm.

Cerium is the most abundant rare earth element present in earth's crust (60–70 ppm) as similar to the abundance of copper. **Lanthanum** has abundance next to cerium. Of the total, 20% of the rare earth elements are used as catalysts (Ce, La), 21% as magnets (Sm, Nd, Dy), 18% as **alloys**, 12% for powder production and 7% as phosphors. These elements are categorized as rare and critical elements owing to their importance in the transition towards green, low carbon economy. They are becoming crucial in various modern technologies due to their excellent optical and magnetic properties.

Nowadays, high-tech industries are supposed to be driven by REEs due their numerous applications like flat screen televisions, compact fluorescent lamps, wind turbines, hybrid cars, sunglasses, mobile phones, disc drives, defense technologies, polishing agents, cigarette lighter, etc.. For high speed communication network, **erbium** (Er) glasses are used for amplifying the optical fibers. REEs are also used for up and down conversion of light energy where Er, Y, Ho were exploited for up-conversions and Yb, Tm, Tb for down-conversions. Use of laser cooling or the magneto caloric effect for refrigeration is an excellent application area of REEs. Rare earth elements like La, Nd, Yb, Y, and Tm are involved in laser cooling purpose.

As a home assignment, find the full version of the *"Review on the recovery and separation of rare earths and transition metals from secondary resources"* by Nilam Swain, Sujata Mishra. **Get ready to give the summary of the review employing the topical vocabulary.**

What are lanthanides? List 15 lanthanides and tell about their applications.

Task 19. **Read and translate into Russian an extract from the article "Platinum-Group Elements – So Many Excellent Properties" (Source: https://pubs.er.usgs.gov/publication/fs20143064). Consult Table 25 with the topical vocabulary from the article.**

Pt GROUP

Table 25

Vocabulary from the Article about Platinum-Group Elements

English word	*Russian equivalent*	*English word*	*Russian equivalent*
indispensable	то, без чего невозможно обойтись; необходимый	**catalytic converter**	каталитический дожигатель выхлопных газов; каталитический нейтрализатор отработавших газов
hitherto	прежде; до этого времени	**automobile exhaust**	автомобильный выхлоп
stream deposits	отложения берегового вала реки	**raw material**	исходный материал
grain	зерно, кристалл	**explosives**	взрывчатые материалы
to intermingle	смешивать; перемешивать	**to refine**	очищать; рафинировать
nugget	золотой самородок	**crude**	сырой, необработанный
to consider	рассматривать	**storage capacities**	объём памяти
worthless	ничего не стоящий; не имеющий никакой ценности; бесполезный	**ubiquitous**	повсеместный;
platinum-enriched	обогащенный платиной	**capacitor**	конденсатор
followed by	за которым следует, за ним следует	**integrated circuits**	интегральные схемы
iridium	иридий	**fiberglass**	стекловолокно
osmium	осмий	**exceptionally**	исключительно;
palladium	палладий	**durable**	долговременный; надёжный; крепкий;
rhodium	родий	**crucibles**	тигель
ruthenium	рутений	**pacemaker**	кардиостимулятор
investment commodity	инвестиционный товар	**stocks, mutual funds, exchange-traded funds**	кции, паевые инвестиционные фонды или биржевые фонды
essential component	необходимая составляющая	**specimen**	образцы; пробы
immiscible	несмешивающийся	**hand specimen**	обделанный образец породы или руды

The platinum-group elements (PGE) include platinum, palladium, rhodium, ruthenium, iridium, and osmium. These metals have similar physical and chemical properties and occur together in nature. The properties of PGE, such as high melting points, corrosion resistance, and catalytic qualities, make them indispensable to many industrial applications. Pre-Columbian peoples found naturally occurring platinum and platinum-rich alloys in stream deposits in Colombia and Ecuador and used them to make jewelry. In the 1500s, Europeans described platinum from the New World as "a substance which it has not hitherto been possible to melt by fire or by any of the Spanish arts." The Spaniards found platinum grains intermingled with gold nuggets they recovered from stream deposits and called the metal "platina." The metal had no known use and was considered worthless. Small samples of platinum-enriched nuggets from South America reached Europe during the 1740s. Platinum was described as a new metal in 1750, followed by iridium and osmium in 1803, palladium and rhodium in 1804, and ruthenium in 1807.

How Do We Use PGE?

Although platinum is well known for its use as jewelry and as an investment commodity, the major applications of PGE are industrial. Their leading use is in catalytic converters, which decrease hydrocarbon, carbon monoxide, and nitrous oxide emissions in automobile exhaust. The chemical industry uses platinum or platinum-rhodium alloys to manufacture specialty silicones and to make nitric oxide, the raw material for fertilizers, explosives, and nitric acid. In the petrochemical industry, platinum-supported catalysts are needed to refine crude oil and to produce high-octane gasoline. In the electronics industry, PGE components increase storage capacities in computer hard disk drives and are ubiquitous in electronic devices, multilayer ceramic capacitors, and hybridized integrated circuits. The glass manufacturing industry uses PGE to produce fiberglass and liquid-crystal and flat-panel displays. PGE alloys are exceptionally hard and durable, making them the best coating for the industrial crucibles used to manufacture chemicals and synthetic materials, including the high-purity sapphire crystals used to make light-emitting diodes. Because platinum does not corrode inside the human body and allergic reactions to platinum are rare, it is used in medical implants such as pacemakers. PGE are also used in cancer-fighting drugs.

Their white coloration, strength, and tarnish resistance make platinum alloys an ideal choice for jewelry. Platinum, palladium, and rhodium are used for investment in the form of coins and bars, and as stocks, mutual funds, or exchange-traded funds.

Where Do PGE Come From?

PGE are among the rarest metals on earth; the upper crust of the Earth contains about 0.0005 parts per million (ppm) platinum. Today, the average grade of PGE in ores mined primarily for their PGE concentrations range from 5 to 15 ppm. Over 100 minerals contain PGE as an essential component. In most rocks, platinum-group minerals are very small, ranging in size from less than a micron to a few hundred microns in diameter. Geologists can spend a lifetime working on rocks enriched in PGE and never see a platinum group mineral in a hand specimen, so the presence of PGE must be confirmed by laboratory analysis.

Most of the world's PGE are concentrated in magmatic ore deposits, which form during the cooling and crystallization of magma. If mafic to ultramafic magmas become saturated in sulfur, an immiscible sulfide liquid will separate from the silicate magma and form globules that naturally concentrate metals like copper, nickel, and PGE. As the magma cools, the PGE-enriched sulfide globules accumulate and crystallize to form PGE mineral deposits. Most magmatic copper-nickel-PGE deposits are found with volcanic and plutonic rocks that form where large volumes of mafic magma move from the Earth's mantle into the crust. Erosion of PGE-enriched rocks and physical concentrations of heavy mineral particles, by the action of moving water, can produce PGE-enriched placer deposits.

MODULE 4
RADIOACTIVITY

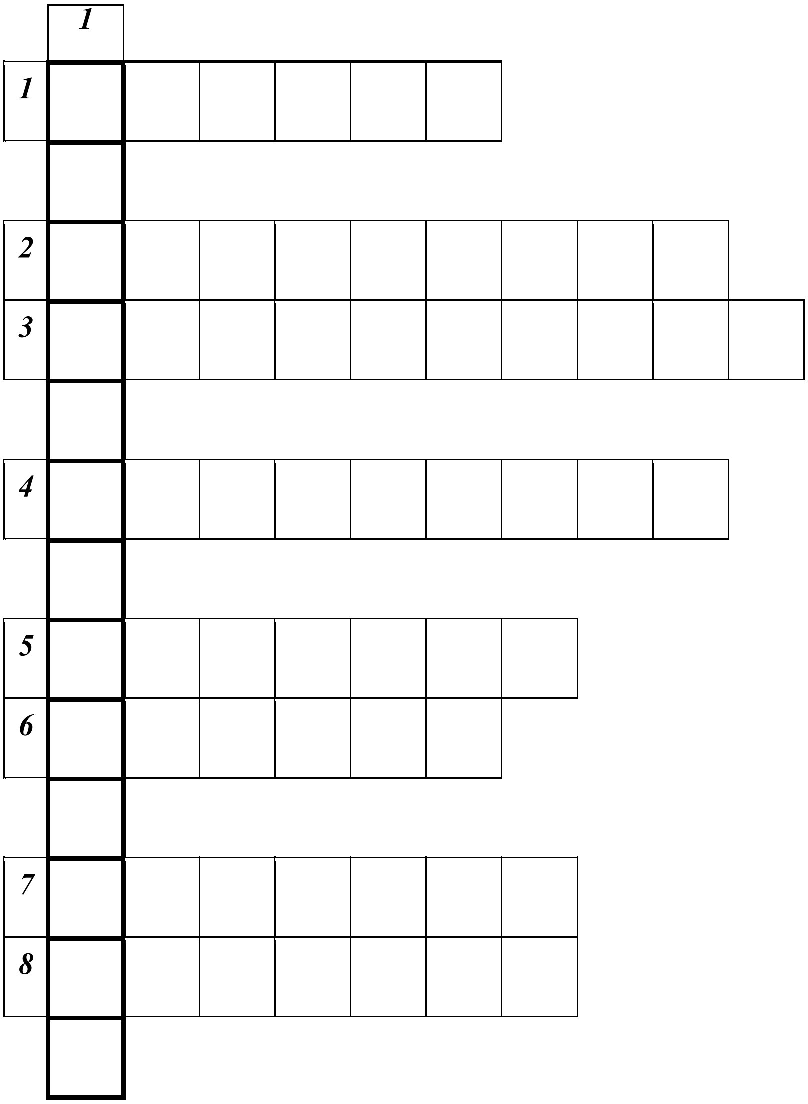
https://do-ra.com/znak-radiacionnoj-opasnosti/

Read the definition of radioactivity.

The atom is the basic constituent of all matter and is one of the smallest units into which matter can be divided. Each atom is composed of a tiny central core of particles, or nucleus, surrounded by a cloud of negatively charged particles called electrons. Most atoms in the physical world are stable, meaning that they are not radioactive. However, some atoms possess excess energy, which causes them to be physically unstable. In order to become stable, an atom rids itself of this extra energy by casting it off in the form of charged particles or electromagnetic waves, known as radiation.

Source: Concepts of Radioactivity https://www.bnl.gov/esh/env/ser/00ser/b-app.pdf

***Task 1.* Warming-up. Solve the crossword puzzles.**



Down:

1. The process of spontaneous transformation of the nucleus, generally with the emission of alpha or beta particles often accompanied by gamma rays. This process is referred to as decay or disintegration of an atom.

Across:

1. A chemical element. Number of protons in the nucleus: 88. All its isotopes are highly radioactive.

2. An instrument for measuring and monitoring exposure to doses of radiation (such as X-rays or gamma rays).
3. The process of adding one or more electrons to, or removing one or more electrons from, atoms or molecules, thereby creating ions.
4. Elements in the periodic table with atomic numbers from 90 to 103. They include most of the well-known elements found in nuclear reactions. Elements with atomic numbers higher than 92 do not occur naturally but are produced artificially by bombarding other elements with particles.
5. A radioactive isotope of the element hydrogen.
6. A nonmetallic solid element. There are both radioactive and non-radioactive isotopes of it. Radioactive isotopes of it are widely used in medical applications. Radioactive element is a fission product and is the largest contributor to people's radiation dose after an accident at a nuclear reactor.
7. A nuclide of an element having the same number of protons but a different number of neutrons.
8. A naturally occurring radioactive metal found in small amounts in soil, rock, water, plants, and animals.

Source: https://www.remm.nlm.gov/dictionary.htm#i

Task 2. **Choose one word from the crossword puzzle and explain it to your fellow-student in other words. Be precise in your explanation.**

https://wordfinder.yourdictionary.com/blog/best-ways-to-solve-a-crossword-puzzle/

Task 3. **Quiz: The discovery of X-Rays and Radioactivity.**

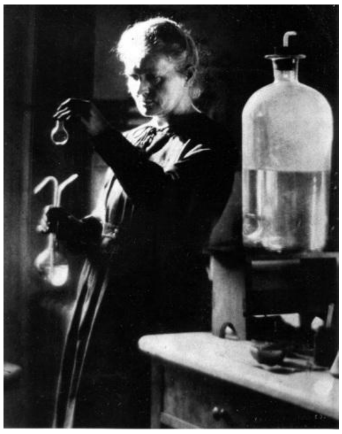
1. Answer the questions below:

1. Who discovered the radioactivity of uranium? When did it happen?
2. Who discovered radioactive elements polonium and radium? What do you know about their biography?

2. Choose the correct option.

In (***1896 / 1866 / 1790 / 1901***) the French scientist (***Henri Becquerel / Marie Curie / Pierre Curie / Ernest Rutherford***) discovered that a compound of uranium spontaneously emits high-energy radiation. This spontaneous emission of radiation is called radioactivity. At (Becquerel`s / ***Curie***`s / ***Rutherford***`s) suggestion, (***Henri Becquerel / Marie Curie / Pierre Curie / Ernest Rutherford***) began experiments to isolate the radioactive components of the compound. Further study of radioactivity, principally by the British scientist (***Henri Becquerel / Marie Curie / Pierre Curie / Ernest Rutherford***), revealed three types of radiation.

Henri Becquerel
https://www.aps.org/publications/apsnews/200803/physicshistory.cfm



Marie Curie
https://www.pinterest.ru/pin/380202393514683845/

Pierre Curie
https://biografiasyotroscuentos.blogspot.com/2015/07/la-ridicula-idea-de-no-volverte-ver.html

Ernest Rutherford
https://www.nzgeo.com/stories/ernest-rutherford/

Task 4. **Read the scientific article about the discovery of radioactivity:** Pierre Radvanyi and Jacques Villain. The discovery of radioactivity, 2017, Comptes Rendus Physique 18(9–10), P. 544–550. DOI: 10.1016/j.crhy.2017.10.008

Choose the most interesting fact revealed in the article and retell it to your fellow-students.

Direct link to the full text of the article:
https://www.researchgate.net/publication/320903689_The_discovery_of_radioactivity

Task 5. **Read and translate into Russian the texts below. Explain in English the meaning of the word in bold.**

TYPES OF RADIOACTIVE DECAY

One element can have different numbers of neutrons. Atoms of the same element (i.e., atoms with the same number of protons) with different numbers of neutrons are called ***isotopes***. Most naturally occurring elements exist as isotopes. For example, most hydrogen atoms have a single proton in their nucleus. However, a small number (about one in a million) of hydrogen atoms have a proton and a neutron in their nuclei. This particular isotope of hydrogen is called deuterium. A very rare form of hydrogen has one proton and two neutrons in the nucleus; this isotope of hydrogen is called tritium. The sum of the number of protons and neutrons in the nucleus is called the mass number of the isotope.

Source: Ball D.W. Introductory Chemistry – 1st Canadian Edition. Chapter 3. Atoms, Molecules, and Ions // D.W. Ball, J.A. Key [Электронный ресурс]. Режим доступа: https://opentextbc.ca/introductorychemistry/chapter/atomic-theory-2/

Nota Bene

The word “*nucleus*” used in the text is of Lating origin and has an irregular plural form “*nuclei*”.

Some other nouns in English that are loan words from Greek and Latin may also have irregular plural forms. Here are some examples of such nouns:

1.	analysis – analyses	10.	phenomenon – phenomena
2.	axis – axes	11.	bacterium – bacteria
3.	basis – bases	12.	datum – data
4.	ellipsis – ellipses	13.	equilibrium – equilibriums (E), equilibria
5.	genesis – geneses	14.	medium – media
6.	hypothesis – hypotheses	15.	formula – formulas (E), formulae
7.	thesis – theses	16.	appendix – appendices
8.	radius – radii, radiuses (E)	17.	index – indexes (E), indices
9.	criterion – criteria	18.	matrix – matrices, matrixes (E)

More examples of such nouns can be studied in Appendix 1 or on the website http://usefulenglish.ru/writing/irregular-plural-nouns.

***Task 6.* Watch two video extracts and fill in the gaps in the text below. Indicate the type of radiation for each paragraph.**

1. **"What Are Radioactive Isotopes?"**
   (https://www.youtube.com/watch?v=UYvx0O8itMA)

2. **"Stable and Unstable Nuclei"**
   (https://www.youtube.com/watch?v=UtZw9jfIxXM)

https://www.sciencephoto.com/media/649481/view

The three most common kinds of radiation given off when a radionuclide decays are __________, __________, and __________ radiation.

1. __________RADIATION

An__________ particle is identical in makeup to the nucleus of a helium atom, consisting of two neutrons and two protons. __________ particles have a positive charge, but because of their large size they cannot travel very far before they lose this energy. They are easily stopped by paper or skin and are only a potential health concern if they are ingested or inhaled. Naturally occurring radioactive elements such as uranium and radon daughters emit __________radiation.

Examples of __________emitters: uranium-238, radon-222, plutonium-239.

2. __________RADIATION

___________particles are electrons with high energy. As a result, __________ particles have a negative charge. __________ radiation may be stopped by materials such as aluminum foil. They have a range in air of several feet. Equally, its small size results in its ionising power being considerably smaller than that of helium atoms (by about 10 times). This stems from the fact that the human body (and all matter more generally) is mainly made up of 'empty' space. The smaller the particle, the lower the risk of it colliding with parts of the atom which, in turn, lowers the risk of damage.

Examples of __________ emitters: caesium-137, strontium-90, hydrogen-3 (tritium), potassium-40.

3. __________RADIATION

__________ radiation is a form of electromagnetic radiation, like radio waves or visible light, but with a much shorter wavelength. It is capable of passing through dense materials such as concrete. It is emitted in many ***radioactive decays*** and may be very penetrating, so require more substantial shielding. The energy of __________ rays depends on the particular source. __________ rays are the main hazard to people dealing with sealed radioactive materials used, for example, in ***industrial gauges*** and radiotherapy machines. All of us receive about 0.5–1 mSv per year of __________radiation from rocks, and in some places, much more. __________activity in a substance (e.g. rock) can be measured with a ***Geiger counter.***

4. __________RADIATION

__________ are uncharged particles mostly released by nuclear fission (the splitting of atoms in a nuclear reactor), and hence are seldom encountered outside the core of a nuclear reactor. Thus they are not normally a problem outside nuclear plants. Fast __________ can be very destructive to human tissue. __________ are the only type of radiation which can make other, non-radioactive materials, become radioactive.

Source: Nuclear Radiation and Health Effects [Электронный ресурс]. Режим доступа: https://www.world-nuclear.org/information-library/safety-and-security/radiation-and-health/nuclear-radiation-and-health-effects.aspx

***Task** 7*. **Summarize the information from the text and two videos.**

Mind the features of a good summary.

A good summary:

- Identifies the author and/ or the source of the original text.
- Synthesizes the writer's key ideas.
- Presents the information neutrally.

https://www.ispcan.org/learn/working-group-child-maltreatment/

Task 8. **Work independently. Study the examples below and answer the questions.**

Examples:

Iodine-131 is an isotope that undergoes decay by *beta emission*:

$$^{131}_{53}\text{I} \rightarrow {}^{131}_{54}\text{Xe} + {}^{0}_{-1}e$$

Radium-226 loses an alpha particle:

$$^{226}_{88}\text{Ra} \rightarrow {}^{222}_{86}\text{Rn} + {}^{4}_{2}\text{He}$$

Questions:

1. What product is formed when uranium-238 undergoes alpha emission?
2. What product forms when plutonium-238 undergoes alpha emission?

Task 9. **Read an extract about radioactive decay and complete the suggested tasks.**

RATES OF RADIOACTIVE DECAY

Some radioisotopes, such as uranium-238, are found in nature even though they are not stable. Other radioisotopes do not exist in nature but can be synthesized in nuclear reactions. To understand this distinction, we must realize that different nuclei undergo radioactive decay at different rates. Many radioisotopes decay essentially completely in fractions of a second, so we do not find them in nature. Uranium-238, on the other hand, decays very slowly. Therefore, despite its instability, we can still observe what remains from its formation in the early history of the universe. Very important characteristic of radioactive decay is half-life, which is the amount of time it takes for one-half of a radioactive isotope to decay. The half-life of a specific radioactive isotope is constant; it is unaffected by conditions and is independent of the initial amount of that isotope. Unlike toxic chemicals, therefore, radioactive atoms cannot be rendered harmless by chemical reaction or by any other practical treatment.

Each radioisotope has its own characteristic half-life. For example, strontium-90 has a half-life ($t_{1/2}$) of 28.8 years:

$$^{90}_{38}\text{Sr} \rightarrow {}^{90}_{39}\text{Y} + {}^{0}_{-1}e.$$

<u>Half-lives</u> as short as millionths of a second and as long as billions of years are known. The half-lives of some radioisotopes are listed in Table 26.

Task 10. **Work with a partner to solve the problem below.**

An isotope of uranium has an atomic number of 92 and a mass number of 235. What is the number of protons and neutrons in the nucleus of this atom?

Write down the equations for the Isotopes presented in Table 26. Here is an example for Tritium (^3H).

Table 26

The Half-Lives of some Radioisotopes

Isotope	***Half-Life***	***Type of Decay***	***Equation***
^{3}H	12.3 years	Beta	$^{3}_{1}T \xrightarrow{\beta-} {}^{3}_{2}He + e^{-} + \bar{\nu}_{e}$
^{14}C	5730 years	Beta	
^{40}K	1.26×10^{9} years	Beta	
^{90}Sr	29.1 years	Beta	
^{131}I	8.04 days	Beta	
^{222}Rn	3.82 days	Alpha	
^{235}U	7.04×10^{8} years	Alpha	
^{238}U	4.47×10^{9} years	Alpha	
^{241}Am	432.7 years	Alpha	
^{239}Pu	24.1×10^{3} years	Alpha	

Task 11. **Read and translate the following passage into Russian.**

RADIOACTIVE DECAY CHAINS

Some nuclei cannot gain stability by a single emission. Consequently, a series of successive emissions occurs as shown for uranium-238, uranium-235 and thorium-232 in **Figure 1**. For example, decay of uranium-238 continues until a stable nucleus lead-206 in this case-is formed. A series of nuclear reactions that begins with an unstable nucleus and terminates with a stable one is known as a radioactive decay chain or a nuclear disintegration series. Three such series occur in nature: uranium-238 to lead-206, uranium-235 to lead-207, and thorium-232 to lead-208. All of the decay processes in these series are either alpha emissions or beta emissions.

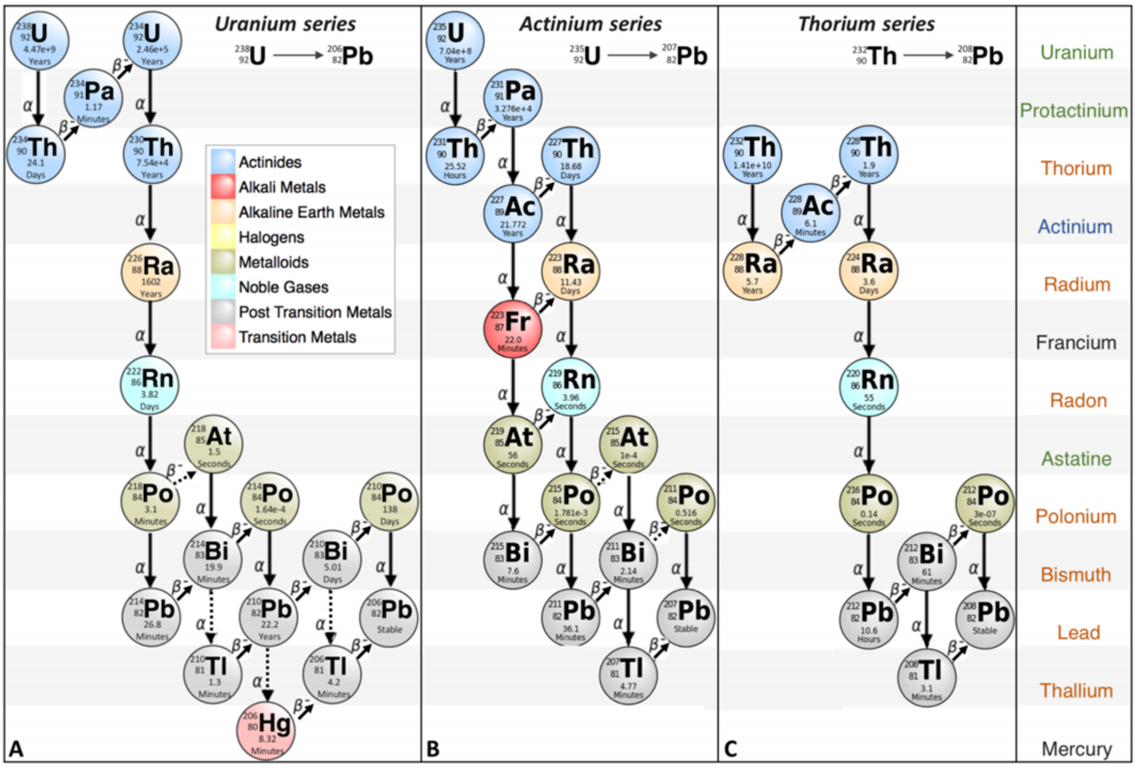


Figure 1. *Decay series of (A) uranium-238 (^{238}U), (B) uranium-235 (^{235}U), and (C) thorium-232 (^{232}Th). Full names of elements shared by all three decay series are in coral, by the two uranium series in green, by ^{235}U and ^{232}Th in blue, and unique to ^{238}U or ^{235}U in black*

Source: Change L.T. Big gaps and short bridges: A model for solving the discontinuity problem // Answers Research Journal. 2016. Vol. 9. P. 149–162.

Task 12. **Discuss with your fellow-students the decay series of uranium-235 (^{235}U), and (C) thorium-232 (^{232}Th). What elements are gases? What stable nucleus is formed in each decay series?**

Task 13. **Read the text below and make a list of radiation detectors mentioned in it.**

DETECTION OF RADIOACTIVITY

A variety of methods have been devised to detect emissions from radioactive substances.

Henri Becquerel discovered radioactivity because radiation caused fogging of photographic plates, and since that time photographic plates and film have been used to detect radioactivity. The radiation affects photographic film in much the same way as X-rays do.

Detection and quantification of emitted radioactive particles such as alpha, beta or high energy gamma and X-rays from a contaminated sample or source can easily be achieved by using different qualitative and quantitative approaches. In contrast to qualitative approach, quantitative methods of radioactivity detection are widely used because of their potential to identify and detect high as well as low radioactivity levels with increased sensitivity and counting accuracy. Gamma /X-Ray spectroscopy, Alpha/r Beta counters, Scintillation detectors including GM counter and LSC detectors are the well-recognized quantitative methods employed for this purpose.

Radioactivity can also be detected and measured by a Geiger counter. The operation of this device is based on the fact that radiation is able to ionize matter. The ions and electrons produced by the ionizing radiation permit conduction of an electrical current.

Some substances, called phosphors, emit light when radiation strikes or passes through them. The radioactivity excites the atoms, ions, or molecules of the phosphor to a higher energy state, and they release this energy as light as they return to their ground states. For example, ZnS responds this way to alpha radiation. An instrument called a scintillation counter detects and counts the flashes of light produced when radiation strikes the phosphor. The flashes of light are magnified electronically and counted to measure the amount of radiation. The flashes of light are magnified electronically and counted to measure the amount of radiation.

Source: Chemistry: The Central Science / T.E. Brown, H.E. LeMay, B.E. Bursten, et al. 13th ed. Prentice Hall, 2014.

Units of radiation and radioactivity

Activity: It's the number of atoms decay per unit time (disintegrations/s), it's measured by curie (Ci) or Becquerel (Bq).

The **becquerel** (Bq) is a unit or measure of actual radioactivity in material. One Becquerel is equal to one disintegration per second. Becquerel is a very small unit of activity, thus multiples of Becquerel are commonly used (1 kBq = 10^3 Bq).

$$1 \text{ Bq} = 1 \text{ disintegration/s.}$$

Curie: Curie is the activity of one gram of pure radium, It's the old unit of activity, and It is a very large amount of activity, thus sub-multiples of curie are commonly used; mCi, μCi, nCi, pCi .

$$1\text{Ci} = 3.7 \times 10^{10} \text{ Bq.}$$

Radiation Doses

In order to quantify how much radiation we are exposed to in our daily lives and to assess potential health impacts as a result, it is necessary to establish a unit of measurement. The basic unit of radiation dose absorbed in tissue is the G**ray (Gy)**.

One gray represents the deposition of one joule of energy per kilogram of tissue.

However, since neutrons and alpha particles cause more damage per gray than gamma or beta radiation, another unit, the **sievert (Sv)** is used in setting radiological protection standards. This weighted unit of measurement takes into account biological effects of different types of radiation and indicates the **equivalent dose**.

One gray of beta or gamma radiation has one Sievert of biological effect, one Gray of alpha particles has 20 Sv effect and one gray of neutrons is equivalent to around 10 Sv (depending on their energy). Since the sievert is a relatively large value, dose to humans is normally measured in millisieverts (mSv), one-thousandth of a sievert.

Note that Sv and Gy measurements are accumulated over time, whereas damage (or effect) depends on the actual dose rate, e.g. mSv per day or year, Gy per day in radiotherapy.

VIDEO REFERENCES

1. **A Simple Guide to the Periodic Table**
Retrieved from
https://www.youtube.com/watch?time_continue=1&v=Tb6Zrl2REIY&feature=emb_log
2. **Alkali metals**
Retrieved from https://www.youtube.com/watch?v=JAPWCJEo9Iw
3. **Chemistry careers – A day in the work life of a chemist**
Retrieved from https://www.youtube.com/watch?v=0eeDUCgJDU4
4. **How to Balance NaBr + Cl_2 = NaCl + Br_2**
Retrieved from https://www.youtube.com/watch?v=7eSBigeIoE4
5. **Livermorium**
Retrieved from http://www.periodicvideos.com/videos/116.htm
6. **Nuclear Engineering. A Fulfilling Career**
Retrieved from https://www.youtube.com/watch?v=2h8KQq6eWGU
7. **Oxygen**
Retrieved from http://www.periodicvideos.com/videos/008.htm
8. **Polonium**
Retrieved from http://www.periodicvideos.com/videos/084.htm
9. **Selenium**
Retrieved from http://www.periodicvideos.com/videos/034.htm
10. **Stable and Unstable Nuclei**
Retrieved from https://www.youtube.com/watch?v=UtZw9jfIxXM
11. **Sulphur**
Retrieved from http://www.periodicvideos.com/videos/016.htm
12. **Tellurium**
Retrieved from http://www.periodicvideos.com/videos/052.htm
13. **The alkaline earth metals**
Retrieved from https://www.youtube.com/watch?v=T7K4Qi5PiFg
14. **University of Birmingham Campus Tour**
Retrieved from https://www.youtube.com/channel/UC5G3iPIJk_s7El-ck-BL1wA
15. **Video from the Vlog of Sophie, a third year undergraduate in chemistry from the University of Birmingham**
Retrieved from https://www.youtube.com/watch?v=oNtu9P5lkkE&feature=emb_title
16. **What Are Radioactive Isotopes?**
Retrieved from https://www.youtube.com/watch?v=UYvx0O8itMA
17. **What is Engineering (What do Engineers do)**
Retrieved from https://www.youtube.com/watch?v=I11y_FLlEp8

REFERENCES

1. Acid base and salt notes [Электронный ресурс]. – Режим доступа: https://physicscatalyst.com/class-7/acid-base-salt-notes.php
2. Ball D.W. Introductory Chemistry – 1st Canadian Edition. Chapter 3. Atoms, Molecules, and Ions // D.W. Ball, J.A. Key [Электронный ресурс]. – Режим доступа: https://opentextbc.ca/introductorychemistry/chapter/atomic-theory-2/
3. Cambridge Dictionary Online. [Электронный ресурс]. – Режим доступа: https://dictionary.cambridge.org
4. Change L.T. Big gaps and short bridges: A model for solving the discontinuity problem // L.T. Change // Answers Research Journal. – 2016. – Vol. 9. – P. 149–162.
5. Chemical properties of oxygen. Health effects of oxygen. Environmental effects of oxygen [Электронный ресурс]. – Режим доступа: https://www.lenntech.com/periodic/elements/o.htm
6. Chemical reaction [Электронный ресурс]. – Режим доступа: https://www.britannica.com/science/chemical-reaction
7. Chemistry: The Central Science. / T.E. Brown, H.E. LeMay, B.E. Bursten, et al. – 13th Edition. Prentice Hall, 2014. – 1248 p.
8. Chemistry: The central science. 14th Edition / T.E. Brown, H.E. LeMay, B.E. Bursten, et al.; Pearson Education Limited, 2017. – 1248 p.
9. Concepts of Radioactivity [Электронный ресурс]. – Режим доступа: https://www.bnl.gov/esh/env/ser/00ser/b-app.pdf
10. Dictionary of Radiation Terms [Электронный ресурс]. – Режим доступа: https://www.remm.nlm.gov/dictionary.htm#i
11. English Discussion on Presentations [Электронный ресурс]. – Режим доступа: https://esldiscussions.com/p/presentations.html
12. Expressing Opinions, Agreement and Disagreement [Электронный ресурс]. – Режим доступа: https://keepsmilingenglish.com/grammar/expressing-opinions-agreement-and-disagreement/
13. Lecture tow (Radioactive Decay) – ResearchGate [Электронный ресурс]. – Режим доступа: https://www.researchgate.net/profile/Nada_Kadhim4/publication/339750025_Radioactivity/links/5e6297a592851c7ce04a2999/Radioactivity.pdf
14. Marie Curie [Электронный ресурс]. – Режим доступа: https://www.pinterest.ru/pin/380202393514683845/
15. Measuring Radiation [Электронный ресурс]. – Режим доступа: https://www.nrc.gov/about-nrc/radiation/health-effects/measuring-radiation.html#:~:text=The%20units%20of%20measure%20for,kilogram%20(C%2Fkg).
16. Nuclear Radiation and Health Effects [Электронный ресурс]. – Режим доступа: https://www.world-nuclear.org/information-library/safety-and-security/radiation-and-health/nuclear-radiation-and-health-effects.aspx
17. Periodic videos [Электронный ресурс]. – Режим доступа: http://www.periodicvideos.com/
18. Radiation – Quantities and Units of Ionizing Radiation. Canadian centre for occupational health and safety [Электронный ресурс]. – Режим доступа: https://www.ccohs.ca/oshanswers/phys_agents/ionizing.html

19. Radvanyi P. The discovery of radioactivity / P. Radvanyi, J. Villain // Comptes Rendus Physique. – 2017. – Vol. 18, no. 9–10. – P. 544–550.
20. Swain N. A review on the recovery and separation of rare earths and transition metals from secondary resources / N. Swain, S. Mishra // Journal of Cleaner Production. – 2019. – Vol. 220 – P. 884–898.
21. The Periodic Table [Электронный ресурс]. – Режим доступа: http://www.elementalmatter.info/
22. This month in physics history. March 1, 1896: Henri Becquerel discovers Radioactivity // APS News March. – 2008. – Vol. 17, no. 3. [Электронный ресурс]. – Режим доступа: https://www.aps.org/publications/apsnews/200803/physicshistory.cfm
23. University of Wisconsin–Madison. Nuclear Engineering [Электронный ресурс]. – Режим доступа: https://guide.wisc.edu/undergraduate/engineering/engineering-physics/nuclear-engineering-bs/
24. Useful English [Электронный ресурс]. – Режим доступа: http://usefulenglish.ru/writing/irregular-plural-nouns
25. Wong V. The Chemistry of the Noble Gases / V. Wong // Catalyst. – 2011. – P. 4–5. [Электронный ресурс]. – Режим доступа: https://www.stem.org.uk/system/files/elibrary-resources/legacy_files_migrated/8436-catalyst_21_3_475.pdf
26. Zientek M.L. Platinum-Group Elements – So Many Excellent Properties / M.L. Zientek, P.J. Loferski // USGS Mineral Resources Program. Fact Sheet. – P. 2014–3064. [Электронный ресурс]. – Режим доступа: https://pubs.er.usgs.gov/publication/fs20143064
27. Гарагуля С.И. Английский язык для делового общения = Learning Business Communication in English : учеб. пособие / С.И. Гарагуля. – Изд. 2-е. – Ростов н/Д : Феникс, 2015. – 268 с.
28. Кутепова М.М. The World of Chemistry: Английский язык для студентов-химиков / М.М. Кутепова. – Москва : Книжный дом «Университет», 2001. – 272 с.
29. Кутолин С.А. Избранные разделы общей и неорганической химии : учебное пособие / С.А. Кутолин, Г.М. Писиченко. – Новосибирск : Изд-во СГУПСа, 2002. – 109 с.
30. Минаевская Л.В. Общая химия. Для инженерно-технических направлений подготовки и специальностей : учебное пособие / Л.В. Минаевская, Н.А. Щеголихина. – Санкт-Петербург : Лань, 2020. – 168 с. – Режим доступа: https://e.lanbook.com/book/126907 (дата обращения: 01.09.2020).
31. Миньяр-Белоручева А.П. Англо-русские обороты научной речи : практикум / А.П. Миньяр-Белоручева. – Москва : Издательский дом «Проспект АП», 2004. – 112 с.

Appendix 1

IRREGULAR PLURAL FORMS IN MATHEMATICAL AND SCIENTIFIC CONTEXTS

Some nouns in English that are loan words from Greek and Latin may have irregular plural forms. Many of these words retain their Latin or Greek plurals in math and science settings. Some of them also have anglicized plural forms that have come into common use.

Group 1
analysis – analys**e**s
axis – ax**e**s
basis – bas**e**s
crisis – cris**e**s
diagnosis – diagnos**e**s
ellipsis – ellips**e**s
emphasis – emphas**e**s
genesis – geneses
hypothesis – hypothes**e**s
parenthesis – parenthes**e**s
synopsis – synops**e**s
synthesis – synthes**e**s
thesis – thes**e**s

Group 2
apparatus – apparatus, apparatuses(E)
calculus – calcul**i**, calculuses(E)
corpus – corpor**a**
focus – focuses, foc**i**
genus – gener**a**, genuses(E)
nucleus – nucle**i**, nucleuses(E)
radius – radi**i**, radiuses(E)
rhombus – rhombuses (E), rhomb**i**
stimulus – stimul**i**
syllabus – syllabuses (E), syllab**i**

Group 3
automaton – automatons (E), automat**a**
criterion – criteri**a**
phenomenon – phenomen**a**
polyhedron – polyhedrons (E), polyhedr**a**

Group 4
bacterium – bacteri**a**
curriculum – curriculums (E), curricul**a**
datum – dat**a**
equilibrium – equilibriums (E), equilibri**a**
forum – forums (E), for**a**
maximum – maximums (E), maxim**a**
medium – medi**a**
memorandum – memorandums (E), memorand**a**
millennium – millenniums (E), millenni**a**
planetarium – planetariums (E), planetari**a**
spectrum – spectr**a**, spectrums (E)
stratum – strat**a**, stratums (E)
symposium – symposiums (E), symposi**a**
vacuum – vacuums (E), vacu**a**

Group 5
antenna – (radio) antennas
antenna – (insects') antenn**ae**
charisma – charismat**a**
dogma – dogmas (E), dogmat**a**
enigma – enigmas (E), enigmat**a**
formula – formulas (E), formul**ae**
stigma – stigmat**a**, stigmas (E)

Group 6
apex – apexes (E), ap**i**ces
appendix – appendixes (E), append**i**ces
index – indexes (E), ind**i**ces
matrix – matr**i**ces, matrixes (E)

Source: http://usefulenglish.ru/writing/irregular-plural-nou

Appendix 2

LIST OF ELEMENTS AND THEIR ATOMIC WEIGHTS

Element	Atomic Mass	Element	Atomic Mass	Element	Atomic Mass
Actinium	227.028	Hafnium	178.49	Promethium	145
Aluminum	26.981539	Hassium	265	Protactinium	231.0359
Americium	243	Helium	4.002602	Radium	226.025
Antimony	121.757	Holmium	164.93032	Radon	222
Argon	39.948	Hydrogen	1.00794	Rhenium	186.207
Arsenic	74.92159	Indium	114.82	Rhodium	102.9055
Astatine	210	Iodine	126.90447	Rubidium	85.4678
Barium	137.327	Iridium	192.22	Ruthenium	101.07
Berkelium	247	Iron	55.847	Rutherfordium	261
Beryllium	9.012182	Krypton	83.8	Samarium	150.36
Bismuth	208.98037	Lanthanum	138.9055	Scandium	44.95591
Bohrium	262	Lawrencium	262	Seaborgium	263
Boron	10.811	Lead	207.2	Selenium	78.96
Bromine	79.904	Lithium	6.941	Silicon	28.0855
Cadmium	112.411	Lutetium	174.967	Silver	107.8682
Calcium	40.078	Magnesium	24.305	Sodium	22.989768
Californium	251	Manganese	54.93805	Strontium	87.62
Carbon	12.011	Meitnerium	266	Sulfur	32.066
Cerium	140.115	Mendelevium	258	Tantalum	180.9479
Cesium	132.90543	Mercury	200.59	Technetium	98
Chlorine	35.4527	Molybdenum	95.94	Tellurium	127.6
Chromium	51.9961	Neodymium	144.24	Terbium	158.92534
Cobalt	58.9332	Neon	20.1797	Thallium	204.3833
Copper	63.546	Neptunium	237.048	Thorium	232.0381
Curium	247	Nickel	58.6934	Thulium	168.93421
Dubnium	262	Niobium	92.90638	Tin	118.71
Dysprosium	162.5	Nitrogen	14.00674	Titanium	47.88
Einsteinium	252	Nobelium	259	Tungsten	183.85
Erbium	167.26	Osmium	190.2	Uranium	238.0289
Europium	151.965	Oxygen	15.9994	Vanadium	50.9415
Fermium	257	Palladium	106.42	Xenon	131.29
Fluorine	18.9984032	Phosphorus	30.973762	Ytterbium	173.04
Francium	223	Platinum	195.08	Yttrium	88.90585
Gadolinium	157.25	Plutonium	244	Zinc	65.39
Gallium	69.723	Polonium	209	Zirconium	91.224
Germanium	72.61	Potassium	39.0983		
Gold	196.96654	Praseodymium	140.90765		

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