МИНОБРНАУКИ РОССИИ

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ENGLISH FOR CHEMISTS

Методические указания для студентов специальностей
18.03.01 «Химическая технология» и
04.03.01 «Химия»

Курск 2015

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Цель методических указаний – научить студентов специальностей «Химическая технология» и «Химия» читать и переводить научную литературу по специальности, вести поиск нужной информации и уметь обобщать полученную информацию. Методические указания основаны на аутентичных текстах, задания и упражнения ориентированы на активное обучение английскому языку и формирование понятийного аппарата по специальности.

Методические указания соответствуют требованиям, отраженным в Общеевропейских компетенциях владения иностранным языком .

Предназначены преподавателям и студентам специальностей 18.03.01 «Химическая технология» и 04.03.01 «Химия» для практических занятий по английскому языку.

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PART I

Unit 1.

CHEMISTRY

I. Read and memorize the words.

1) chemistry – химия
2) science of matter – наука о материи
3) chemical reactions – химическая реакция
4) chemical bond – химическая связь
5) natural sciences – естественные науки
6) elementary particle – элементарная частица
7) atom – атом
8) molecule − молекула
9) substance − вещество
10) metal – металл
11) crystal − кристалл
12) aggregate − заполнитель
13) solid − твердый
14) liquid − жидкий
15) gas – газ, газообразный
16) state − состояние
17) interaction − взаимодействие
18) matter − вещество
19) energy − энергия
20) laboratory glassware − лабораторное стеклянное оборудование
21) chemical reaction − химическая реакция
22) chemical equation – химическое уравнение
23) entropy − энтропия
24) structure − структура
25) chemical composition – химический состав
26) tool − инструмент
27) chemical analysis – химический анализ

28) spectroscopy – спектроскопия
29) chromatography – хроматография
30) scientist – ученый
31) research – исследование
32) chemist − химик

II. Match Russian and English equivalents.

1. matter	**a)** жидкий
2. solid	**b)** вещество
3. substance	**c)** уравнение
4. scientist	**d)** связи
5. liquid	**e)** твердый
6. bonds	**f)** ученый
7. equation	**g)** исследование
8. tool	**h)** реакция
9. research	**i)** инструмент
10. reaction	**j)** материя

III. Read and translate the text.

Chemistry is the science of matter, especially its chemical reactions, but also its composition, structure and properties. Chemistry is concerned with atoms and their interactions with other atoms, and particularly with the properties of chemical bonds.

Chemistry is sometimes called "the central science" because it connects physics with other natural sciences such as geology and biology. Chemistry is a branch of physical science but distinct from physics.

The etymology of the word chemistry has been much disputed. The genesis of chemistry can be traced to certain practices, known as alchemy, which had been practiced for several millennia in various parts of the world, particularly the Middle East.

Traditional chemistry starts with the study of elementary particles, atoms, molecules, substances, metals, crystals and other aggregates of matter: in solid, liquid, and gas states, whether in isolation or combination. The interactions, reactions and transformations that are studied in chemistry are the result of interaction either between different chemical substances or between matter and energy. They are studied in a chemistry laboratory using various forms of laboratory glassware.

A chemical reaction is a transformation of some substances into one or more other substances. It can be symbolically depicted through a chemical equation. The number of atoms on the left and the right in the equation for a chemical transformation is most often equal. The nature of chemical reactions a substance may undergo and the energy changes that may accompany it are constrained by certain basic rules, known as chemical laws.

Energy and entropy considerations are invariably important in almost all chemical studies. Chemical substances are classified in terms of their structure, phase as well as their chemical compositions. They can be analyzed using the tools of chemical analysis, e.g. spectroscopy and chromatography. Scientists engaged in chemical research are known as chemists. Most chemists specialize in one or more sub-disciplines.

IV. Answer the questions.

1. What is chemistry? What is it concerned with?
2. Why is chemistry called “the central science”?
3. What is the etymology of the word chemistry?
4. What does chemistry study?
5. What is a chemical reaction?
6. How can it be symbolically depicted?
7. What terms are chemical substances classified in?
8. What are spectroscopy and chromatography used for?
9. What are scientists engaged in chemical research called?

V. Retell the text.

Unit 2
FUNDAMENTAL CONCEPTS OF CHEMISTRY

I. Read and memorize the words.

1) consist of – состоять из
2) charged core – заряженное ядро

3) contain – содержать
4) maintain – поддерживать, удерживать
5) retain – сохранять
6) carbon – углерод
7) uranium – уран
8) differ from – отличаться от
9) artificially – искусственно
10) gain – получать
11) sodium – натрий
12) chloride – хлорид
13) neutral – salts
14) electrical force – электрическая сила
15) oxygen – кислород
16) hydrogen – водород
17) involve – включать
18) formation – образование
19) destruction – разрушение
20) occur – происходить

II. Match the Russian - English equivalents.

1.	chemical formula	**a)**	протон
2.	chemical equation	**b)**	элемент
3.	proton	**c)**	атомный
4.	neutron	**d)**	ядерный
5.	element	**e)**	ион
6.	electron	**f)**	химическое соединение
7.	atomic	**g)**	нейтрон
8.	nucleus	**h)**	химическая реакция
9.	molecule	**i)**	атомное число
10.	cation	**j)**	химические связи
11.	anion	**k)**	химическая формула
12.	chemical compound	**l)**	молекула
13.	chemical reaction	**m)**	электрон
14.	chemical bonds	**n)**	химическое уравнение
15.	ion	**o)**	катион
16.	atomic number	**p)**	анион

III. Read the text and fill in the gaps with the following expressions in appropriate forms. Use each expression only once.

chemical formula	chemical equation	proton	neutron	element
atomic nucleus	chemical bonds	electron	molecule	cation
chemical reaction	chemical compound	anion	ion	molecule
atomic number				

An atom is a collection of matter consisting of a positively charged core (the _____________) which contains ___________ and ___________ and which maintains a number of electrons to balance the positive charge in the nucleus. The atom is also the smallest portion into which an __________ can be divided and still retain its properties, made up of a dense, positively charged nucleus surrounded by a system of ____________.

The most basic chemical substances are the chemical elements. They are building blocks of all other substances. An element is a class of atoms which have the same number of protons in the nucleus. This number is known as the __________ ____________ of the element. For example, all atoms with 6 protons in their nuclei are atoms of the chemical element carbon, and all atoms with 92 protons in their nuclei are atoms of the element uranium. Each chemical element is made up of only one kind of atom. The atoms of one element differ from those of all other elements. Chemists use letters of the alphabet as symbols for the elements. In total, 117 elements have been observed as of 2007, of which 94 occur naturally on Earth. Others have been produced artificially.

An __________ is an atom or a molecule that has lost or gained one or more electrons. Positively charged __________ (e.g. sodium cation Na^+) and negatively charged __________ (e.g. chloride Cl^-) can form neutral salts (e.g. sodium chloride NaCl). Electrical forces at the atomic level create ___________ _________ that join two or more atoms together, forming ____________. Some molecules consist of atoms of a single element. Oxygen molecules, for example, are made up of two oxygen atoms. Chemists represent the oxygen molecule O_2. The 2 indicates the number of atoms in the molecule. When atoms of two or more different elements bond together, they form a

__________________. Water is a compound made up of two hydrogen atoms and one oxygen atom. The __________ __________ for a water molecule is H_2O.

Compounds are formed or broken down by means of _______ _______. All chemical reactions involve the formation or destruction of chemical bonds. Chemists use ___________ __________ to express what occurs in chemical reactions. Chemical equations consist of chemical formulas and symbols that show the substances involved in chemical change. For example, the equation $C + O_2 = CO_2$ expresses the chemical change that occurs when one carbon atom reacts, or bonds, with an oxygen molecule. The reaction produces one molecule of carbon dioxide, which has the formula CO_2.

IV. Answer the questions.

1. What is an atom?
2. What are the most basic chemical substances?
3. How many elements have been known so far?
4. What do electrical forces at the atomic level create?
5. Why do chemists represent the oxygen molecule as O_2?
6. What do chemical reactions involve?

V. Retell the text.

Unit 3
LABORATORY

I. Laboratory Equipment.

Match the following expressions with pictures, there are three extra ones. What are their Russian equivalents?

1) single neck flat bottom flask	17) test tube
2) Erlenmeyer flask	18) bath
3) crucible	19) pH meter
4) graduated cylinder	20) pH buffers
5) mortar and pestle	21) watch glass
6) filtering flask	22) ring
7) pH sticks	23) condenser
8) three neck round bottom flask	24) Buchner flask

9) burette (buret)	25) Petri dish
10) beaker	26) pipette
11) oven	27) volumetric flask
12) round bottom boiling flask	28) funnel
13) Buchner funnel	29) vial
14) tongs	30) filter paper
15) separatory funnel	31) analytical balance
16) stand	

1. 
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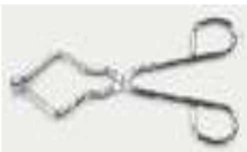
20. 
21. 
22. 

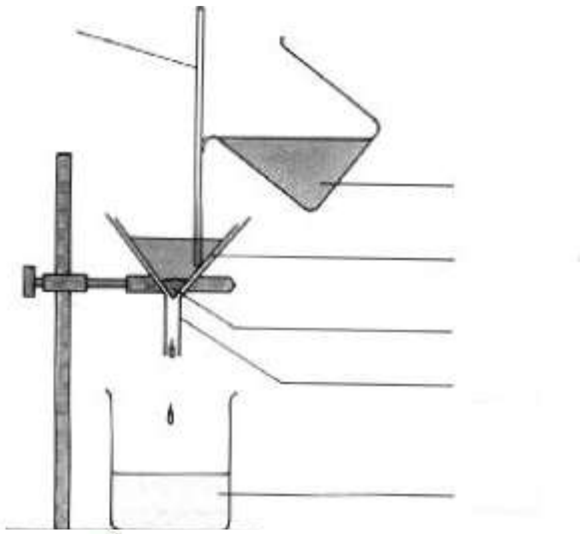
23. 
24. 
25. 

26. 
27. 
28. 

II. Fill the following schemes with suitable expressions. What are their Russian equivalents?

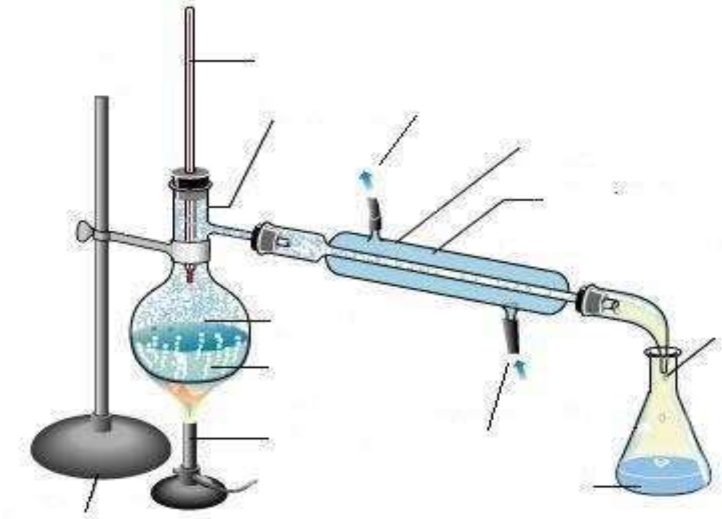
<u>Filtration</u>

funnel
filter paper
mixture
residue
glass rod
filtrate



<u>Distillation</u>

Bunsen burner
condenser
cooling water
condensed water
thermometer
mixture
stand
distillate
distillation flask
water outlet steam
cold water inlet



III. Alchemy. Read and memorize the words.

1) precious metals – драгоценные металлы
2) to cure - лечить
3) to prolong - продлевать
4) to seek to - искать
5) goal - цель
6) advancement – продвижение, прогресс

7) achievement - достижение
8) hydrochloric acid – соляная кислота
9) nitric acid – азотная кислота
10) potash – поташ, углекислый калий
11) sodium carbonate – углекислый натрий
12) arsenic - мышьяк
13) antimony - сурьма
14) bismuth - висмут
15) to invent - изобретать
16) to develop - разрабатывать
17) to lay the foundation – заложить фундамент
18) to denote – обозначать, различать
19) to persecute - преследовать
20) confusion – беспорядок, путаница
21) to overlap - перекрывать

IV. Read and translate the text.
What is the meaning of the expressions in *italics*?

Alchemy in the Middle Ages was a mixture of science, philosophy and mysticism. At the heart of medieval alchemy was the idea that all matter was composed of four elements: earth, air, fire and water. With the right combination of elements, any substance on earth might be formed. This included precious metals as well as elixirs to cure disease and prolong life. Alchemists believed that the "transmutation" of one substance into another was possible; thus we have the cliché of medieval alchemists seeking to *"turn lead into gold."*

Goals:

- To find the *"philosopher's stone,"* an elusive substance that was believed to make possible the creation of an *elixir of immortality* and the transmutation of common substances into gold.
- In the later Middle Ages, to use alchemy as a tool in the advancement of medicine.

Achievements:

• Medieval alchemists produced hydrochloric acid, nitric acid, potash and sodium carbonate.

• They were able to identify the elements arsenic, antimony, and bismuth.

• Through their experiments, medieval alchemists invented and developed laboratory devices
and procedures that are, in modified form, still used today.

• The practice of alchemy laid the foundation for the development of chemistry as a scientific
discipline.

There were often many symbols for an element. For a time, the astronomical symbols of the planets were used to denote the elements. However, as alchemists came to be persecuted, particularly in medieval times, secret symbols were invented. This led to a great deal of confusion, so you will find some overlap of symbols. The symbols were in common use through the 17th century; some are still in use today.

V. Answer the questions.

1. What is alchemy? What is the difference between alchemy and modern science?
2. Have you ever read a book or seen a film that dealt with alchemy?
3. Are there any famous alchemists you know?
4. Were the goals of alchemy achieved?
5. What are the goals of modern chemistry?
6. What was the meaning of the word ‘element’ in the Middle Ages? Is it different now?
7. What symbols do we use for elements today?

Unit 4.

THE PERIODIC TABLE OF ELEMENTS

I. Read and memorize the words and phrases.

1) to discover – открывать, обнаруживать
2) periodic table – периодическая таблица
3) independently – независимо

4) according to - в соответствии, согласно
5) property - свойство
6) to be based on – быть основанным на
7) designation - обозначение
8) outer shell – внешняя оболочка
9) alkali - щелочь
10) alkaline earth metals – щелочноземельные металлы
11) halogens - галогены
12) noble gases – инертные газы
13) to conduct - проводить
14) heat - тепло
15) malleable – легко формируемый (ковкий)
16) ductile – легко формируемый,
17) electropositive - электроположительный
18) valence- валентность
19) electronegative - электроотрицательный
20) metalloid semimetal – металлоид
21) intermediate- промежуточный

II. Read and translate the text.

Approximately, 115 elements have been discovered to date. These elements are organized in a periodic table of elements. Two seventeenth-century chemists, Dmitri Mendeleev and Julius Meyer, independently organized the early periodic table that evolved into the modern periodic table of elements.

The periodic table of elements is structured according to the properties of the elements. Mendeleev's early experiments classified the elements according to their properties and reactivity with oxygen and grouped the elements in octaves (eight). Elements have chemical symbols that are used for their representation in the periodic table (O is oxygen and Zn is zinc). Some of the symbols are based on their original names, usually their Latin origin (Fe is iron [ferrum] and Na is sodium [stannum]).The elements are organized by periods (horizontal rows) and *groups* (vertical columns). Elements in vertical columns are groups (or families), they usually have similar chemical properties, and they are identified by group numbers 1 through 18 (newer labels). The groups labeled 1A through 8A (older labeling) are often called *main group elements*. The1 through 18 labels have been recommended by the International Union of Pure and Applied Chemistry(IUPAC) and adopted by the American Chemical Society(ACS), but the more commonly used is 1A (or 1) through 8A (or 8) group designations. Elements in the same group also have (in common) the same number of electron(s) in their outermost shell (i.e., group 6 elements have six electrons in their outer shell). Groups 1A, 2A, 7A, and 8A have specific names based on their properties:

- Group 1A: Alkali metals (Li, Na, K, Rb, Cs, Fr)
- Group 2A: Alkaline earth metals (Be, Mg, Ca, Sr,Ba, Ra)
- Group 7A: Halogens (F, Cl, Br, I, At)
- Group 8A: Noble gases (He, Ne, Ar, Kr, Xe, Rn).

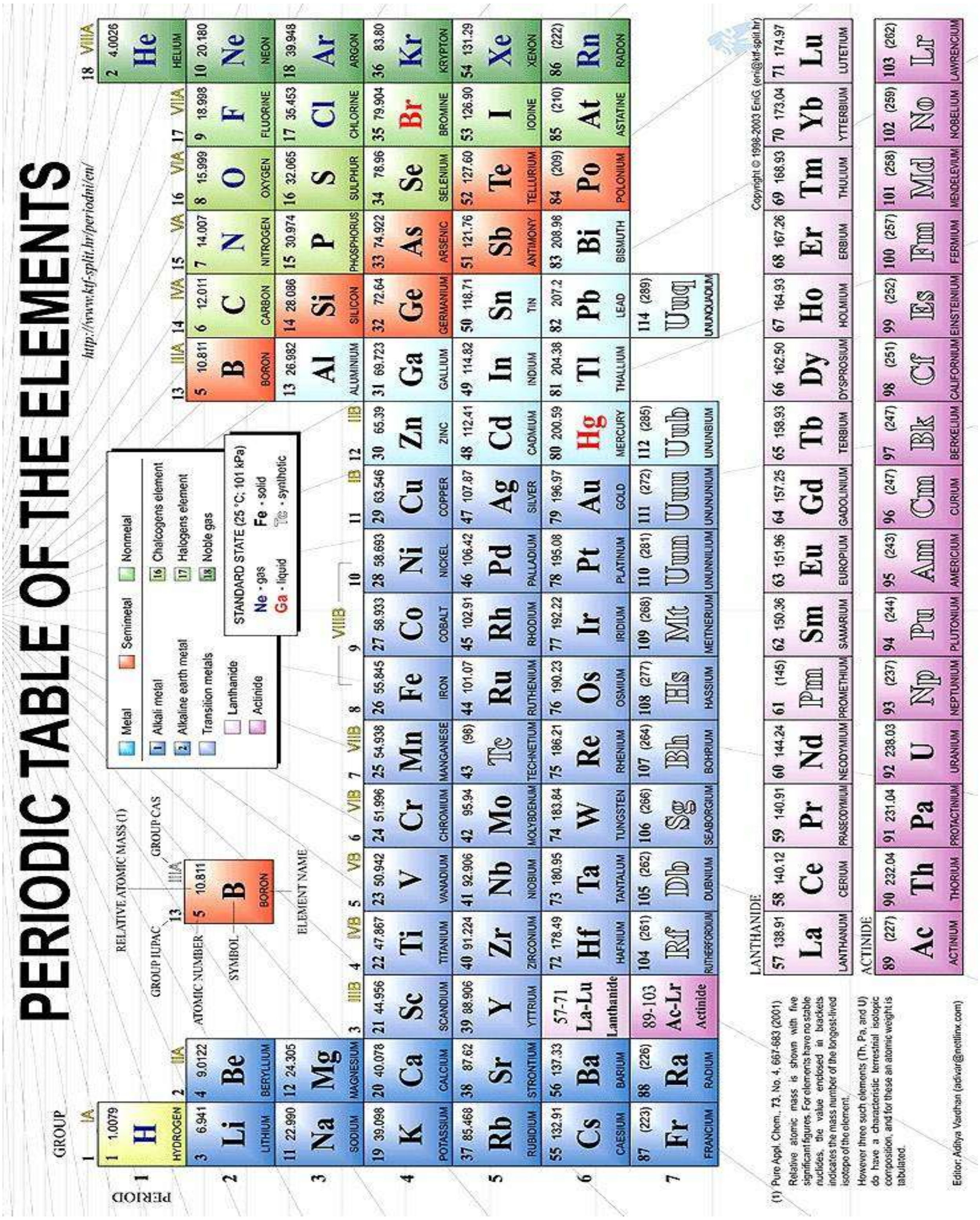
Elements in the same period have the same number of electron shells (or levels). Seven periods can be found in the modern periodic table. Elements in the middle and left side of the table are classified as metals (Na, Fe, Hg). A *metal* is an element that is shiny, conducts electricity and heat, is malleable (easily shaped), and is ductile (pulled into wires). Metals are electropositive, having a greater tendency to lose their valence electrons. Elements in the upper-right corner of the table are classified as nonmetals (C, F, S). A *nonmetal* is an element with poor conducting properties. Nonmetals are electronegative, having a greater tendency to gain valence electrons. A *metalloid* or *semimetal* is an element with properties that are intermediate between those of metals and nonmetals, such as semiconductivity. They are found between metals and nonmetals in the periodic table.

III. Put the following expressions into correct places.

symbol	atomic number	alkali metals	lanthanides
atomic weight	group	halogens	actinides
name	row	noble gases	alkaline earth metals

The most convenient presentation of the chemical elements is in the periodic table of the chemical elements, which groups elements by ____________ ____________. Due to its ingenious arrangement, columns, or ______________, and _______________, or periods, of elements in the table either share several chemical properties, or follow a certain trend in characteristics such as atomic radius, electronegativity, electron affinity, etc. The main value of the periodic table is the ability to predict the chemical properties of an element based on its location on the table. The properties vary differently when moving vertically along the __________ of the table, than when moving horizontally along the _______________.

The periodic table was first devised in 1869 by the Russian chemist Dmitri Mendeleev. Mendeleev intended the table to illustrate recurring ("periodic") trends in the properties of the elements. The layout of the table has been refined and extended over time, as new elements have been discovered, and new theoretical models have been developed to explain chemical behaviour. Various layouts are possible to emphasize different aspects of behaviour; the most common forms, however, are still quite similar to Mendeleev's original design.


PERIODIC TABLE OF THE ELEMENTS
http://www.ktf-split.hr/periodni/en/
GROUP
PERIOD
RELATIVE ATOMIC MASS (1)
GROUP IUPAC
GROUP CAS
ATOMIC NUMBER
SYMBOL
ELEMENT NAME
Metal
Semimetal
Nonmetal
Alkali metal
Alkaline earth metal
Transition metals
Lanthanide
Actinide
Chalcogens element
Halogens element
Noble gas
STANDARD STATE (25 °C; 101 kPa)
Ne - gas
Fe - solid
Ga - liquid
Tc - synthetic
1 H 1.0079 HYDROGEN
2 He 4.0026 HELIUM
3 Li 6.941 LITHIUM
4 Be 9.0122 BERYLLIUM
5 B 10.811 BORON
6 C 12.011 CARBON
7 N 14.007 NITROGEN
8 O 15.999 OXYGEN
9 F 18.998 FLUORINE
10 Ne 20.180 NEON
11 Na 22.990 SODIUM
12 Mg 24.305 MAGNESIUM
13 Al 26.982 ALUMINIUM
14 Si 28.086 SILICON
15 P 30.974 PHOSPHORUS
16 S 32.065 SULPHUR
17 Cl 35.453 CHLORINE
18 Ar 39.948 ARGON
19 K 39.098 POTASSIUM
20 Ca 40.078 CALCIUM
21 Sc 44.956 SCANDIUM
22 Ti 47.867 TITANIUM
23 V 50.942 VANADIUM
24 Cr 51.996 CHROMIUM
25 Mn 54.938 MANGANESE
26 Fe 55.845 IRON
27 Co 58.933 COBALT
28 Ni 58.693 NICKEL
29 Cu 63.546 COPPER
30 Zn 65.39 ZINC
31 Ga 69.723 GALLIUM
32 Ge 72.64 GERMANIUM
33 As 74.922 ARSENIC
34 Se 78.96 SELENIUM
35 Br 79.904 BROMINE
36 Kr 83.80 KRYPTON
37 Rb 85.468 RUBIDIUM
38 Sr 87.62 STRONTIUM
39 Y 88.906 YTTRIUM
40 Zr 91.224 ZIRCONIUM
41 Nb 92.906 NIOBIUM
42 Mo 95.94 MOLYBDENUM
43 Tc (98) TECHNETIUM
44 Ru 101.07 RUTHENIUM
45 Rh 102.91 RHODIUM
46 Pd 106.42 PALLADIUM
47 Ag 107.87 SILVER
48 Cd 112.41 CADMIUM
49 In 114.82 INDIUM
50 Sn 118.71 TIN
51 Sb 121.76 ANTIMONY
52 Te 127.60 TELLURIUM
53 I 126.90 IODINE
54 Xe 131.29 XENON
55 Cs 132.91 CAESIUM
56 Ba 137.33 BARIUM
57-71 La-Lu Lanthanide
72 Hf 178.49 HAFNIUM
73 Ta 180.95 TANTALUM
74 W 183.84 TUNGSTEN
75 Re 186.21 RHENIUM
76 Os 190.23 OSMIUM
77 Ir 192.22 IRIDIUM
78 Pt 195.08 PLATINUM
79 Au 196.97 GOLD
80 Hg 200.59 MERCURY
81 Tl 204.38 THALLIUM
82 Pb 207.2 LEAD
83 Bi 208.98 BISMUTH
84 Po (209) POLONIUM
85 At (210) ASTATINE
86 Rn (222) RADON
87 Fr (223) FRANCIUM
88 Ra (226) RADIUM
89-103 Ac-Lr Actinide
104 Rf (261) RUTHERFORDIUM
105 Db (262) DUBNIUM
106 Sg (266) SEABORGIUM
107 Bh (264) BOHRIUM
108 Hs (277) HASSIUM
109 Mt (268) MEITNERIUM
110 Uun (281) UNUNNILIUM
111 Uuu (272) UNUNUNIUM
112 Uub (285) UNUNBIUM
114 Uuq (289) UNUNQUADIUM
LANTHANIDE
57 La 138.91 LANTHANUM
58 Ce 140.12 CERIUM
59 Pr 140.91 PRASEODYMIUM
60 Nd 144.24 NEODYMIUM
61 Pm (145) PROMETHIUM
62 Sm 150.36 SAMARIUM
63 Eu 151.96 EUROPIUM
64 Gd 157.25 GADOLINIUM
65 Tb 158.93 TERBIUM
66 Dy 162.50 DYSPROSIUM
67 Ho 164.93 HOLMIUM
68 Er 167.26 ERBIUM
69 Tm 168.93 THULIUM
70 Yb 173.04 YTTERBIUM
71 Lu 174.97 LUTETIUM
ACTINIDE
89 Ac (227) ACTINIUM
90 Th 232.04 THORIUM
91 Pa 231.04 PROTACTINIUM
92 U 238.03 URANIUM
93 Np (237) NEPTUNIUM
94 Pu (244) PLUTONIUM
95 Am (243) AMERICIUM
96 Cm (247) CURIUM
97 Bk (247) BERKELIUM
98 Cf (251) CALIFORNIUM
99 Es (252) EINSTEINIUM
100 Fm (257) FERMIUM
101 Md (258) MENDELEVIUM
102 No (259) NOBELIUM
103 Lr (262) LAWRENCIUM
(1) Pure Appl. Chem., 73, No. 4, 667-683 (2001)
Relative atomic mass is shown with five significant figures. For elements have no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.
However three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.
Editor: Aditya Vardhan (adivar@netlinx.com)
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IV. Answer the questions.

1. Which elements are: metals, nonmetals, metalloids?
2. What does the term ‘chemical series’ mean?
3. What are the synonyms of the following words used in the article?
   Ingenious location recurring to refine to emphasize unique
4. What are the following elements called in Russian?

Aluminium **Al**	Chromium **Cr**	Lithium **Li**	Platinum **Pt**
Argentums silver **Ag**	Copper **Cu**	Magnesium **Mg**	Lead **Pb**
Antimony arseni **Sb**	Fluorine **F**	Manganese **Mn**	Radium **Ra**
Astatine **At**	Ferrum iron **Fe**	Nitrogen **N**	Sulphur sulfur **S**
Boron **B**	Hydrogen **H**	Sodium **Na**	Silicon **Si**
Barium **Ba**	Helium He	Neon **Ne**	Stannum **Sn**
Bromine **Br**	Hydrargyrum **Hg**	Nickel **Ni**	Tin **Sn**
Carbon **C**	Mercury **Hg**	Oxygen **O**	Tungsten **W**
Calcium **Ca**	Iodine **I**	Phosphorus **P**	Uraniu **U**
Chlorine **Cl**	Kalium potassium **K**	Plumbum **Pb**	Zinc **Zn**

Unit 5
MATTER. STATES OF MATTER

I. Read the following article. What is the meaning of the expressions in bold?

There are four main **states of matter**: **solids, liquids, gases** and **plasmas**. Each of these states is also known as a **phase**. Elements and compounds can move from one phase to another phase when special **physical forces** are present. One example of those forces is **temperature**. The phase or state of matter can change when the temperature changes. Generally, as the temperature rises, matter moves to a more active state. Phase describes a physical state of matter. The key word to notice is physical. Things only move from one phase to another by physical means. If **energy is added** (like **increasing** the temperature or **increasing pressure**) or if energy **is taken away** (like **freezing** something or **decreasing pressure**) you have created a physical change.

One compound or element can move from phase to phase, but still be the same substance. You can see **water vapor** over a boiling **pot** of water. That vapor (or gas) can **condense** and become a **drop of water**. If you put that drop in the freezer, it would become a solid. No matter what phase it was in, it was always water. It always had the same chemical properties. On the other hand, a **chemical change** would change the way the water acted, eventually making it not water, but something completely new.

II. Choose the correct answer.

1. What is the term used to describe the phase change when a liquid becomes a solid?

evaporation *condensation* *freezing*

2. What term is used to describe the phase change of a solid to a liquid?

freezing *melting* *boiling*

3. What is the term used to describe the phase change of a liquid to a gas?

boiling *condensation* *melting*

4. What is the densest state of matter?

solids *liquids* *gases* *plasmas*

III. Find the synonyms of the following expressions in the article.

phase of matter rise of temperature drop of temperature

IV. Read and translate the text.

The Fourth State of Matter

There are three classic states of matter: solid, liquid, and gas; however, plasma is considered by some scientists to be the fourth state of matter. The plasma state is not related to blood plasma, the most common usage of the word; rather, the term has been used in physics since the 1920s to represent an ionized gas. Lightning is commonly seen as a form of plasma. Plasma is found in both ordinary and exotic places. When an electric current is passed through neon gas, it produces both plasma and light. Lightning is a massive electrical discharge in the atmosphere that creates a jagged column of plasma. Part of a comet's streaming tail is plasma from gas ionized by sunlight and other unknown processes. The Sun is a 1.5-millionkilometer ball of plasma. It is heated by nuclear fusion. Scientists study plasma for practical purposes. In an effort to harness fusion energy on Earth, physicists are studying devices that create and confine very hot plasmas in magnetic fields. In space, plasma processes are largely responsible for shielding Earth from cosmic radiation, and much of the Sun's influence on Earth occurs by energy transfer through the ionized layers of the upper atmosphere.

Unit 6
INORGANIC CHEMISTRY

I. Answer the questions.

What is inorganic chemistry?

What is the difference between inorganic and organic chemistry?

II. Read and understand the text. What is the meaning of the words in bold?

Types of Inorganic Chemical Reactions

Elements and compounds **react with** each other in numerous ways. Almost every inorganic chemical reaction falls into one or more of four broad categories.

1. **Combination Reactions**

Two or more **reactants form** one **product** in a combination reaction. An example of a combination reaction is the formation of **sulfur dioxide** when sulfur is burned in air:

$$\mathbf{S\ (s) + O_2\ (g) \dashrightarrow SO_2\ (g)}$$

2. **Decomposition Reactions**

In a decomposition reaction, a compound **breaks down** into two or more substances. Decomposition usually results from **electrolysis** or **heating**. An example of a decomposition reaction is the **breakdown** of **mercury (II) oxide** into its component elements:

$$\mathbf{2HgO\ (s) + heat \dashrightarrow 2Hg\ (l) + O_2\ (g)}$$

1. **Single Displacement Reactions**

A single displacement reaction is characterized by an atom or ion of a single compound **replacing** an atom of another element. An example of a single displacement reaction is the displacement of copper ions in a **copper sulfate solution** by zinc metal, forming **zinc sulfate**:

$$\mathbf{Zn\ (s) + CuSO4\ (aq) \dashrightarrow Cu\ (s) + ZnSO_4\ (aq)}$$

Single displacement reactions are often subdivided into more specific categories, e.g., **redox reactions** − chemical reactions which involve oxidation and reduction.

2. **Double Displacement Reactions**

Double displacement reactions also may be called **metathesis reactions**. In this type of reaction, elements from two compounds displace each other to form new compounds. An example of a double displacement reaction occurs when solutions of **calcium chloride** and **silver nitrate** react to form **insoluble silver chloride** in a solution of **calcium nitrate**:

$$\mathbf{CaCl_2\ (aq) + 2AgNO_3\ (aq) \dashrightarrow Ca(NO_3)_2\ (aq) + 2AgCl\ (s)}$$

A **neutralization reaction** is a specific type of double displacement reaction that occurs when an **acid** reacts with a **base**, producing a **solution of salt and water**. An example of a neutralization reaction is the reaction of **hydrochloric acid** and **sodium hydroxide** to form **sodium chloride** and water:

$$\mathbf{HCl\ (aq) + NaOH\ (aq) \dashrightarrow NaCl\ (aq) + H_2O\ (l)}$$

Remember that reactions can belong to more than one category. Also, it would be possible to present more specific categories, such as **combustion reactions** or **precipitation reactions.**

III. Answer the questions.

1. What are the main types of inorganic chemical reactions?
2. What is the difference between single and double displacement reactions?
3. What other types of inorganic reactions apart from the 4 main ones are mentioned in the text?
4. What is the difference between: **chemical reaction − chemical equation**?
5. What is the difference between: **to break down – breakdown**?
6. What is the meaning of the following abbreviations used in chemical equations in the text: **(s) (g) (l) (aq)**?

IV. Read the text again and find the names of inorganic compounds. What are they called in Russian?

V. What is the meaning of the following expressions?

Oxide	Nitrate	Iodide
Chloride	Fluoride	Acid
Hydroxide	Sulfate/sulphate	Bromide

VI. What do we call fluorides, chlorides, bromides and iodides?

VII. Divide the compound mentioned in the text into the following groups:

Binary compounds	**Ternary compounds**	**Acids**

Binary compounds

1. **containing a metallic element**

   metal with a **fixed charge**

1) Which of the compounds mentioned in the article falls into this group?

____ - __________________

K2O - potassium oxide

ZnCl2 - _________________

ZnO - _________________

2) What does the fact that the metallic element has a fixed charge mean?

metal with a **non-fixed charge**

Fe_2O_3 - ferr**ic** oxide

FeO - ferr**ous** oxide

CuS - ______________

Cu_2S - ________________

3) Which suffix means higher valence and which lower valence?

- ic - ________________________

- ous - _______________________

4) These are called ‘trivial names’. What does it mean?

5) Which of the compounds mentioned in the article falls into this group? Why does its name look different?

________ - __________________

Hg2O - mercury (I) oxide

6) So, according to this system:

Fe_2O_3-_____________________

FeO - _______________________

CuS - _____________________

Cu_2S - _______________________

7) Which names would you prefer to use trivial or systematic ones? Why?

8) Why is there no such problem with the 1st group – compound containing a metal with a fixed charge?

2. containing a non-metallic element

CO - carbon **mono**xide

CO2 -_________________

OsO4 - _______________

N2O3 - **di**nitrogen **tri**oxide

N2O5 - ______________

Ternary compounds

if there is **only 1 such compound**

$Na2CO3$ - sodium carbon**ate**

$Na2BO3$ - ____________________

if there are **2 such compounds**

$NaNO2$ - sodium nitr**ite** $NaNO3$ - sodium nitr**ate**

$Na2SO3$ - ____________________

$Na2SO4$ - ______________________

1) Which suffix means higher oxidation number and which lower oxidation number?

-ite - __________________________

-ate - __________________________

2) Which of the compounds mentioned in the article are ternary compounds? Which of the 2groups do they fall into?

Acids

1. **Hydrogen acids**

   HCl - hydrochlor**ic** acid

   HF - ____________________

2. **Oxoacids/Oxyacids**

   H2SO4 - sulfur**ic** acid

   H2SO3 - sulfur**ous** acid

   HNO3 - _______________________

   HNO2 - ______________________

1) Which suffix means higher oxidation number and which lower oxidation number?

-ic - ________________________

-ous - ________________________

2) Give the names of the following compounds:

PI_3 - ___________________________

P_2O_5 - ___________________________

SO_3 - ___________________________

$Ca(NO_3)_2$ - ___________________________

$Ca(NO_2)_2$ - ___________________________

NaOH - ___________________________

$Ca(OH)_2$ - ___________________________

Unit 7
ORGANIC CHEMISTRY

I. Read and memorize the words and phrases.

1) to depend on - зависеть от
2) basis - основа
3) limitless - безграничный
4) gemstone – драгоценный камень
5) drilling - сверление
6) cutting- резание, гранение
7) lubricant – смазочный материал
8) rust – ржавчина
9) pure - чистый
10) charcoal – древесный уголь
11) abundant – обильный, богатый
12) amount - количество
13) fine - мелкий
14) particle - частица
15) toxin - токсин
16) taste – вкус
17) odor – запах

II. Read the 10 facts about carbon and match the 2 parts of each statement.

Life on earth **depends on** the chemical element carbon, which is present in every living thing. Carbon is so important; it forms the **basis** for two branches of chemistry: **organic chemistry** and **biochemistry**.

The Chemical Basis for Life

1. Carbon is the basis for organic chemistry_____________ .
2. Carbon is a nonmetal that can **bond with itself** and many other chemical elements, ___________ .
3. **Elemental carbon** can take the form of one of the hardest substances (diamond) ____________.
4. Carbon is made in the interiors of stars, ______________

5. Carbon compounds have **limitless** uses. In its **elemental form**, diamond is a **gemstone** and used for **drilling/cutting**; graphite is used in pencils, as a lubricant, and to protect against **rust**; ___________ .
6. Carbon has the highest melting/sublimation point of the elements. The melting point of diamond is ~3550°C, _________ .
7. **Pure carbon** exists free in nature _____________ .
8. The origin of the name 'carbon' comes from the Latin word carbo, for **charcoal** __________ .
9. Pure carbon is considered non-toxic, ___________ .
10. Carbon is the fourth most **abundant** element in the universe − __________

a) ______ as it occurs in all living organisms.
b) ______or one of the softest (graphite).
c) ______ though it was not produced in the Big Bang.
d) ______ and has been known since prehistoric time.
e) ______ forming nearly ten million compounds.
f) ______ hydrogen, helium, and oxygen are found in higher amounts, by mass.
g) ______ although inhalation of fine particles, such as soot, can damage lung tissue.
h) ______ The German and French words for charcoal are similar.
i) ______ while charcoal is used to remove toxins, tastes, and odors.
j) ______ with the sublimation point of carbon around 3800°C.

III. What is the meaning of the words in bold?

IV. Read the following paragraph.

Organic nomenclature

The simplest organic compounds are hydrocarbons. Hydrocarbons contain only two elements, hydrogen and carbon. A saturated hydrocarbon or alkane is a hydrocarbon in which all of the carbon-carbon bonds are single bonds. Each carbon atom forms four bonds and each hydrogen forms a single bond to a carbon. The bonding around each carbon atom is tetrahedra**l**, so all bond angles are 109.5°. As a result, the carbon atoms in higher alkanes are arranged in zig-zag rather than linear patterns.

V. Match the Russian - English equivalents.

hydrocarbon	насыщенный
saturated	углеводород
single	модель
bond	угол
tetrahedral	тетраэдральный
angle	линейный
linear	одиночный
pattern	связь

VI. Answer the questions.

1. What does the term ‘saturated hydrocarbons’ mean?
2. Which hydrocarbons are ‘unsaturated’? What type of bonds do they have?
3. What is the pronunciation of the following word?
   a) Alkanes alkenes alkynes
   b) Methane __ __
   c) Ethane – ethene − ethyne
   d) Propane – propene − propyne
   e) Butane − butene − butyne
   f) Pentane − pentene − pentyne
   g) Hexane − hexene − hexyne

VII. Some of these carbohydrates also have trivial names. What are they?

Ethylene   propylene   acetylene   methylacetylene   butylenes

VIII. Read and answer the questions.

What does the term ‘derivative’ mean?
What is a functional group?

In chemistry, a **derivative** is a compound that is formed from a similar compound if one atom is replaced with another atom or group of atoms. Different organic compounds containing similar carbon or non-carbon groups – so-called **functional groups** – within the molecules react similarly. This leads to the compounds being grouped in families according to the functional groups that they contain.

IX. Read and understand.

In a supermarket or in a pharmacy, the term “organic” is used to describe products that are grown entirely through natural biological processes, without the use of synthetic materials. “Organic” fruits and vegetables are not treated with synthetic fertilizers or pesticides; “organic” chickens or cows are raised from organically grown feed, without the use of antibiotics. The growing “organic” market, despite higher prices over “conventionally grown” foods, indicates that some consumers believe that molecules made by a living plant or animal are different from, and indeed better than, those made in a laboratory.

In the early 18th century, the term “organic” had similar origins in chemistry. At that time, most chemists believed that compounds produced by living systems could not be made by any laboratory procedure. Scientists coined the chemical term “organic” to distinguish between compounds obtained from living organisms and those obtained from mineral sources.

In 1828, a German chemist, Friedrich Wöhler, obtained urea from the reaction of two inorganic compounds, potassium cyanate and ammonium chloride. Since then, many other organic compounds have been prepared from inorganic materials. Organic chemistry today is the study of compounds in which carbon is the principal element. Animals, plants, and fossil fuels contain a remarkable variety of carbon compounds. What is it about the carbon atom that allows it to form such a variety of compounds, a variety that allows the diversity we see in living organisms? The answer lies in the fact that carbon atoms can form four bonds. Carbon atoms have another special property: They can bond together to form chains, rings, spheres, sheets, and tubes of almost any size and can form combinations of single, double, and triple covalent bonds. This versatility allows the formation of a huge variety of very large organic molecules.

X. Answer the questions.

1. What is the term "organic" used to describe?
2. Did the term "organic" have similar meaning origins in chemistry and in supermarket or pharmacy in the 18^{th} century?
3. What did Friedrich Wöhler do in 1828? Why was it important?
4. What is organic chemistry today?

Unit 8
ENVIRONMENTAL CHEMISTRY

I. Read the following article about environmental chemistry and fill the gaps with appropriate forms of the words in brackets. Use prefixes and suffixes.

Environmental chemistry is the______________(science) study of the________________(chemistry) and ________________ (biochemistry) phenomena that occur in _______________ (nature) places. It can be defined as the study of the **sources**, reactions, transport, effects, and fates of _______________ (chemistry) **species** in the air, soil, and water environments; and the effect of human activity on these. Environmental chemistry is an ____________________ (discipline) science that includes ______________(atmosphere), ____________ (aqua) and soil chemistry, as well as _________ (heavy) **relying on** _______ (analysis) chemistry and being related to _____________ (environment) and other areas of science.

Environmental chemistry involves first _______________ (understand) how the **uncontaminated** environment works, which chemicals in what **concentrations** are present, and with what effects. Without this it would be _____________ (possible) to __________________ (accurate) study the effects humans have on the environment through the **release** of chemicals.

II. Answer the questions.

1. What is the meaning of the word 'interdisciplinary'?
2. What branches of chemistry are essential for environmental chemistry?

3. What is the meaning of the following terms? Match them with their definitions. What are the meanings of the words **in bold?**

a) pollutant CFCs
b) contaminant pH
c) biochemical-oxygen demand (BOD)
d) dissolved oxygen (DO)

_______________ a class of volatile compounds consisting of carbon, chlorine, and fluorine;
Commonly called **freons**, which have been in refrigeration mechanisms, and, until banned from use several years ago, as propellants in spray cans;
_______________ a substance that has a **detrimental impact** on the environment it is in _______________ a substance present in the environment as a result of human activity, but without **harmful** effects. However, it is sometimes the case that toxic or harmful effects from contamination only become apparent at a later date;
_______________ one of the most important **indicators** of the condition of a water body, necessary for the life of fish and most other aquatic organisms;
_______________ the amount of oxygen, expressed in **milligrams per liter**, that is removed from aquatic environments by the life processes of micro-organisms. It is used in water quality management and **assessment**, ecology and environmental science;
______________ the measure of the **acidity** or **alkalinity** of a solution.

III. Read and answer the questions.

1. What is the difference between 'environmental chemistry' and 'green chemistry? Can these 2 terms be used as synonyms?
2. Read the following paragraph and fill the gaps with these 2 terms, as appropriate.

____________________________, also called sustainable chemistry, is a chemical philosophy encouraging the design of products and processes that reduce or eliminate the use and generation of hazardous substances. Whereas ____________________________ is the chemistry of the natural environment, and of pollutant chemicals in nature, ______________________ seeks to reduce and prevent pollution at its source.

IV. Read the following 12 points of Green Chemistry and choose the best alternative for each of the underlined expressions. What is the meaning of the words in bold? Do you agree with these principles? Do you think these principles should be observed? Is it possible to observe them?

1. **Prevent waste:** Design chemical <u>synthesies/syntheses</u> to prevent **waste**, leaving no waste to treat or <u>clean up/clean down</u>.
2. **Design <u>safer/more safe</u> chemicals and products:** Design chemical products to be <u>full/fully</u> <u>effective/efficient</u>, yet have little or no toxicity.
3. **Design less hazardous chemical <u>syntheses/synthesies</u>:** Design <u>syntheses/synthesies</u> to use and generate <u>matters/substances</u> with little or no toxicity to humans and the environment.
4. **Use <u>renewable/renewible</u> feedstocks:** Use **raw materi**als and **feedstocks** that are <u>renewable/renewible</u> rather than **depleting**.
5. **Use catalysts, not stoichiometric reagents:** Minimize waste by using **catalytic** <u>equations/reactions</u>. **Catalysts** <u>use/are used</u> in small amounts and can carry <u>out/carry</u> a single reaction many times.
6. **Avoid chemical derivates/derivatives:** Avoid using blocking or protecting groups or any temporary modifications if possible. <u>Derivatives/derivates</u> use additional **reagents** and generate waste.
7. **Maximize atom <u>economy/economics</u>:** Design <u>synthesies/syntheses</u> so that the final <u>reactant/ product</u> <u>contains/includes</u> the maximum proportion of the starting materials.
8. **Use safer <u>solvents/soluents</u> and reaction conditions:** Avoid using <u>soluents/solvents</u>, **separation agents**, or other auxiliary

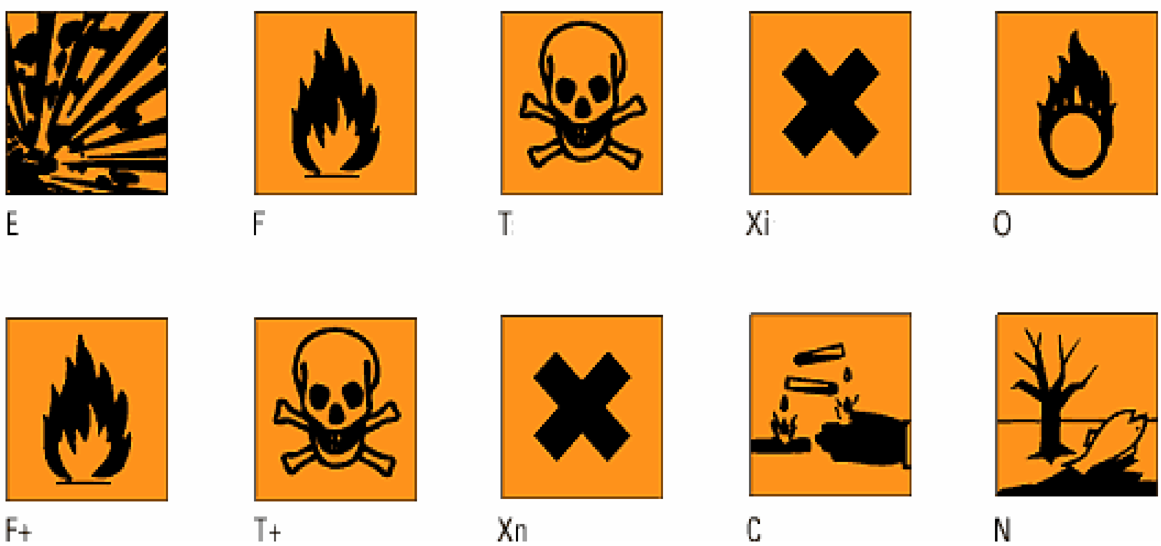
chemicals. If these chemicals are necessary, use **innocuous** chemicals.

9. **Increase/decrease energy efficiency:** Run chemical reactions at **ambient** temperature and pressure whenever possible.
10. **Design chemicals and products to degrade after use:** Design chemical products to break down/break up to innocuous substances after use so that they do not accumulate in the environment.
11. **Analyze in real time to prevent pollution:** Include in-process real-time monitoring and control during syntheses/synthesies to minimize or eliminate the formation of **byproducts**.
12. **Minimize the potential for accidents:** Design chemicals and their formulas/forms (solid, liquid, or gas) to minimize the potential for chemical accidents consisting of/including explosions, fires, and **releases** to the environment.

V. Hazard symbols

1. Which products are hazardous?
2. What is the meaning of the following symbols? Match the phrases with symbols:

1. irritant	6. toxic
2. harmful	7. corrosive
3. highly flammable	8. oxidizing
4. dangerous for the environment	9. extremely flammable
5. explosive	10. very toxic



3. Now match the symbols with the phrases explaining their meaning.

_____________ Living tissues as well as equipment are destroyed on contact with these chemicals.

_____________ Substances that are very hazardous to health when breathed, swallowed or in contact with the skin and may even lead to death.

_____________ Substances which are harmful to the aquatic, as well as the non-aquatic environment or which have a detrimental effect at longer term.

_____________ Substances which may explode under certain conditions.

_____________ Substances that can ignite combustible material or worsen existing fires and thus make fire-fighting more difficult.

_____________ Substances which may have an irritant effect on skin, eyes and respiratory organs.

___________Liquids with flash points below 0°C and a boiling point of max. 35°C.

___________Gaseous substances which are flammable in contact with air at ambient temperature and pressure.

___________Spontaneously flammable substances

___________Substances sensitive to moisture.

___________Liquids with flash point bellow 21°C.

Unit 9
ANALYTICAL CHEMISTRY

I. Answer the questions.

1. How would you define analytical chemistry? What is the scope of its study?
2. Is analytical chemistry concerned with a particular type of chemical compounds, like organic or inorganic chemistry?
3. What is the difference between qualitative and quantitative analysis?

II. Titration

1. Match the following terms with their definitions:

analyte titrant endpoint indicator solution solute

___________ a homogeneous mixture composed of two or more substances

___________ a substance that is dissolved in another substance, known as solvent. These two are present in a solution.

___________ is a solution of the substance whose concentration is unknown and sought in the analysis

___________ is a solution in which the concentration of a solute is precisely known is the point at which the titration is complete, as determined by an indicator.

___________ is a substance used to show the presence of a chemical substance by its colour.

III. Read the following article and fill the gaps with the above expressions. They can be used more than once. Put the number the individual steps of the titration analysis into chronological order.

A titration is a method of analysis that will allow you to determine the precise _____________ of a reaction and therefore the precise quantity of reactant in the titration flask. A buret is used to deliver the second reactant to the flask and an _____________ or pH Meter is used to detect the ______________ of the reaction.

- ✓ Begin by preparing your buret. Your buret should be **conditioned** and **filled with** _____________ solution. You should check for air bubbles and leaks, before proceeding with the titration.
- ✓ As you approach the _____________, you may need to add a **partial** drop of _____________. You can do this with a rapid spin of a teflon **stopcock** or by partially opening the stopcock and **rinsing** the partial drop into the flask with a **wash bottle**.
- ✓ Use the buret to deliver a stream of _____________ to within a couple of mL of your expected _____________. You will see the _____________ change color when the _____________ hits the solution in the flask, but the color change disappears upon **stirring**.
- ✓ When you have reached the _____________, read the final volume in the buret and record it in your notebook.
- ✓ Approach the _____________ more slowly and watch the color of your flask carefully. Use a wash bottle to **rinse** the sides of the flask

and the tip of the buret, to be sure all ____________ ismixed in the flask. Prepare the ____________ to be analyzed by placing it in a clean Erlenmeyer flask or beaker. If your sample is a solid, **make sure** it is completely dissolved. Put a magnetic **stirrer** in the flask and add ____________.

- ✓ **Subtract** the initial volume to determine the amount of ________ delivered. Use this, the concentration of the __________, and the **stoichiometry** of the titration reaction to calculate the number of moles of reactant in your __________ solution.
- ✓ Take an **initial volume reading** and record it in your notebook. Before beginning a titration, you should always calculate the expected ____________ volume.

IV. The following items of laboratory equipment are mentioned in the text. Match their name with the pictures.



V. FLAME TESTS: Trial by Fire

1. **Read the following article and fill the gaps with suitable forms of the words in brackets. Use prefixes and suffixes.**
2. **What is the meaning of the phrase ‘Trial by Fire’, used as a subtitle to this article?**
3. **What is the meaning of the expressions in bold? Match them with their definitions:**
   a) to change
   b) to wash something with clean water
   c) to discover the facts about something
   d) to put something quickly into a liquid and take it out again

What is the flame test?

The flame test is used to ____________ (visual) **determine** the identity of an ___________(known) metal or metalloid ion based on the _________________ (character) colour the salt turns the flame of a bunsen burner. The heat of the flame **converts** the metal ions into atoms which become excite and emit visible light. The ____________ (character) **emission spectra** can be used to **differentiate** between some elements.

How is the test performed?

First, you need a clean wire **loop**. Platinum or nickel-chromium loops are most common. They may be cleaned by **dipping** in hydrochloric or nitric acid, followed by **rinsing** with _____________ (distill) or _____________ (deionise) water. Test the _______________ (clean) of the loop by**inserting** it into a bunsen burner flame. If a burst of color is produced, the loop was not _____________ (sufficient) clean. Ideally, a **separate** loop is used for each sample to be tested, but a loop may be _____________ (careful) cleaned between tests. The clean loop is dipped in either a powder or solution of an ionic salt. The loop with sample is placed in the clear or blue part of the flame and the **resulting** colour is observed.

What are the limitations of this test?

The value of the flame test is limited by interference from other brighter colours and by **ambiguities** where certain different metals cause the same flame colour. Sodium, in particular, is present in most compounds and will colour the flame. Sometimes a coloured glass is used to filter out light from one metal. Cobalt glass is often used to filter out the yellow of sodium.

Flame Test Colours

Fill the names of the chemical elements into the following chart.

Symbol	Element	Color
As		Blue
B		Bright green
Ba		Pale/Yellowish Green
Ca		Orange to red
Cs		Blue
Fe		Gold
In		Blue

K		Lilac to red
Li		Magenta to carmine
Mg		Bright white
Mo		Yellowish green
Na		Intense yellow
P		Pale bluish green
Pb		Blue
Rb		Red to purple-red
Sb		Pale green
Se		Azure blue
Sr		Crimson
Te		Pale green
Tl		Pure green
Zn		Bluish-green to whitish-green

Unit 10
EVERYDAY CHEMISTRY

I. Answer the questions.

1. Do you remember the definition of chemistry from Unit 2? What does it say?
2. How many meanings does the word "chemistry" have?

II. Read the following article. What is the meaning of the words in bold?

Have you ever wondered about the importance of chemistry in everyday life? This is a question you may ask yourself if you're taking chemistry. Otherwise, finding an answer is one of the most common chemistry homework assignments. Here's a look at why chemistry is important. Chemistry helps you to understand the world around you.

Chemistry is important in everyday life because... Everything is **made of chemicals**. You are made of chemicals. So is your dog. So is your desk. So is the sun. Drugs are chemicals. Food is made from chemicals.

Most of the human body is made up of water, H_2O, with **cells** consisting of 65-90% water by weight. Therefore, it isn't surprising that most of a human body's mass is oxygen. Carbon, the basic unit for organic molecules, comes in second. 99% of the mass of the human body is made up of just six elements: oxygen (65%), carbon (18%), hydrogen (10%), nitrogen (3%), calcium (1.5%), and phosphorus (1.0%).

Many of the changes you **observe** in the world around you are **caused** by chemical reactions. Examples include changing colours of leaves, cooking food and getting clean.

When leaves appear green, it is because they contain an abundance of chlorophyll. There is so much chlorophyll in an active leaf that the green masks other pigment colors. Light regulates chlorophyll production, so as autumn days grow shorter, less chlorophyll is produced. The decomposition rate of chlorophyll remains constant, so the green color starts to fade from leaves.

Cooking is chemistry. Everything you can **touch** or **taste** or **smell** is a chemical. When you study chemistry, you come to understand a bit about how things work.

Chemistry isn't secret knowledge, useless to anyone but a scientist. It's the explanation for everyday things, like why laundry **detergent** works better in hot water or how baking soda works or why not all **pain relievers** work equally well on a **headache**. If you know some chemistry, you can make educated choices about everyday products that you use.

Soaps are sodium or potassium fatty acids salts, produced from the hydrolysis of fats in a chemical reaction called saponification. Each soap molecule has a long hydrocarbon chain, sometimes called its "tail", with a carboxylate "head". In water, the sodium or potassium ions float free, leaving a negatively-charged head. Soap is an excellent **cleanser** because of its ability to act as an emulsifying agent. An emulsifier is capable of **dispersing** one liquid into another **immiscible** liquid. This means that while oil (which attracts dirt) doesn't naturally mix with water, soap can **suspend** oil/dirt in such a way that it can be **removed**.

Knowing some chemistry can help you make day to day decisions that affect your life.

(Adapted from: http://chemistry.about.com/od/chemistry101/a/basics.htm)

III. Answer the questions.

1. Do you agree that chemistry is the explanation of everyday things?
2. Can you give some other examples of chemistry in everyday life?

IV. Everyday Chemistry Quiz.
Take the following Everyday Chemistry Quiz. What is the meaning of the words in bold?

1. Two household chemicals you should never mix include:
a) Vinegar and baking soda. Those bubbles could be toxic!
b) **Bleach** and water. **Diluting** bleach only makes it more dangerous.
c) Oil and water. They don't mix and aren't meant to!
d) Bleach and ammonia. Chloramine vapors can be deadly!

2. The sweat-blocking ingredient in antiperspirant is often:
a) An aluminum compound.
b) A calcium compound.
c) A magnesium compound.
d) A tin or stannous compound.

3. The acid in most car batteries, sometimes known as 'Oil of Vitriol', is:
a) Acetic acid.
b) Hydrochloric acid.
c) Nitric acid.
d) Sulfuric acid

4. One important source of Vitamin C is citrus fruit. Vitamin C is:
a) Ascorbic acid.
b) Citric acid.
c) Salicylic acid.
d) Tricarboxylic acid.

5. Soft drinks may contain many different acids. The acid that produces fizz or bubbles is: a Ascorbic acid.
a) Carbonic acid.
b) Citric acid. Phosphoric acid.

6. If you are making soaps and detergents from scratch, one of your starting ingredients will be:
a) Potassium hydroxide.

b) Sodium hydroxide.
c) Sodium chloride.
d) Calcium carbonate.

7. Chocolate and cocoa naturally contain relatively high levels of which two metals?
a) Cadmium and lead.
b) Aluminum and iron.
c) Cadmium and mercury.
d) Lead and cobalt.

V. Read the following abstract. Match the following expressions with individual parts of the abstract according to the information they contain.

methods *results* *background/reasons* *problem* *conclusions/significance*

Alteration of the platelet serotonin transporter in romantic love

____________ The evolutionary consequences of love are so important that there must be some long-established biological process regulating it. Recent findings suggest that the serotonin (5-HT) transporter might be linked to both neuroticism and sexual behaviour as well as to obsessivecompulsive disorder (OCD).

____________ The similarities between an overvalued idea, such as that typical of subjects in the early phase of a love relationship, and obsession, prompted us to explore the possibility that the two conditions might share alterations at the level of the 5-HT transporter.

____________ Twenty subjects who had recently (within the previous 6 months) fallen in love, 20 unmedicated OCD patients and 20 normal controls, were included in the study. The 5-HT transporter was evaluated with the specific binding of 3H-paroxetine (3H-Par) to platelet membranes.

____________ The results showed that the density of 3H-Par binding sites was significantly lower in subjects who had recently fallen in love and in OCD patients than in controls.

____________ The main finding of the present study is that subjects who were in the early romantic phase of a love relationship were not different from OCD patients in terms of the density of the platelet 5-HT transporter, which proved to be significantly lower than in the normal controls. This would suggest common neurochemical changes involving the 5-HT system, linked to psychological dimensions shared by the two conditions, perhaps at an ideational level.

PART II СМЫСЛОВОЙ АНАЛИЗ ТЕКТОВ

Text I

Chemistry has been called “the central science” because it relates to and bridges all of the physical and biological sciences. For example, biology, as it focuses more and more on processes at the cellular and molecular level, depends heavily on chemistry. There is great overlap within the fields in biochemistry, the study of the chemical processes that take place in biological systems, and in chemical biology, the latter term being used to describe the broader area of the application of chemical techniques and principles to biology-related problems.

Chemistry is the study of matter – in its many forms—and the way these forms react with each other. It deals with the smallest of ions that are used in the human body to process energy, with the inner workings of the Earth’s core, and even with the faraway study of the chemical composition of rocks on Mars. Chemistry is a pervasive science, or as an anonymous writer once wrote, “What in the world *isn’t* chemistry?” To understand basic chemistry is to have a healthy understanding of the complex world around us. It allows us to be amused by knowing that two of the most dangerous chemicals, sodium and chlorine, when combined, make our food taste good (salt, sodium chloride). It also helps us realize that combining chemicals released to the atmosphere by human activities can have serious health effects on us all, or that the wings of a butterfly may hold the key to a cure for cancer. Chemists today work hard to solve many of the leading problems in industry, agriculture, science, and health.

While we can define chemistry, it is more difficult to describe what a chemist actually does. The comic book image of a chemist as someone in a white coat surrounded by test tubes and beakers, if it ever had any basis in reality, is far from accurate now. Nowadays, while the white coat may still be in style, a chemist is more likely to be surrounded by complicated instruments such as spectrometers and chromatographs. The type of work a chemist does falls into four general areas: first, synthetic chemistry is involved with the discovery of new materials or finding improved ways of making existing ones; materials can be organic, for example, pharmaceuticals and polymers, or inorganic such as superconducting materials. Second, analytical chemistry is focused on determining what or how much of a substance is present, or identifying its structure, or developing new ways of making these measurements. Third, physical chemistry is the study of reactions and energetics and finding the physical properties of a material and the relation between these properties and composition and structure. Finally, computational or theoretical chemistry involves the use of theoretical methods to calculate expected properties and so guide those doing experimental work. The work of any chemist usually involves several of these aspects, even though one may be predominant. Chemists may also call themselves organic chemists if they work primarily with compounds of carbon; inorganic chemists, if they work mostly with other elements; biochemists if they work with biological materials or systems; geochemists if they are concerned with geological materials; astrochemists if they study the chemistry of stars and other planets; and so on. There are many other combinations.

Chemical engineers, on the other hand, usually have different training than chemists. Both disciplines require knowledge of chemistry, but the chemical engineer is more concerned with practical applications, and there are differences in novelty and scale. A chemist is more likely to be developing new compounds and materials; a chemical engineer is more likely to be working with existing substances. A chemist may make a few grams of a new compound, while a chemical engineer will scale up the process to make it by the ton, and at a profit. The chemical engineer will be more concerned with heating and cooling large reaction vessels, pumps and piping to transfer materials, plant design and operation, and process optimization, while a chemist will be more concerned with establishing the details of the reactions before the plant is designed. These differences are generalizations; there is often much overlap.

The variety of fields in which a chemist can work is extensive. Because chemistry is such a broad science, chemists can work on the interface with many other sciences and even move into other fields. The primary area, of course, is the chemical industry, pharmaceuticals, polymers and plastics, semiconductor and other solid-state materials, and related fields. Examples of activities include research, quality control and property testing, and customer service. In other areas, modern medicine depends heavily on chemistry and involves many chemists in drug development and testing. Forensic science has a very large chemistry component, and many forensic scientists are in fact chemists. These are just a few of the fields in which chemistry plays a role.

Tasks to the Text

I. What is this text about?

II. Find key words.

III. Make a graph of the text.

IV. Answer the questions:

1. What is the difference between a chemist and a chemical engineer?
2. Are the scopes of employment of a chemist and a chemical engineer different?
3. What are your future prospects?

V. Put three questions to the text.

VI. Write the summery of the text.

VII. Entitle the text.

Text II

Great scientists are usually remembered for their great ideas. Many of these same scientists, however, also proposed ideas that were later proven wrong. Russian chemist Dimitri Mendeleev is justly celebrated for proposing the periodic table and predicting the existence and properties of elements that had not yet been discovered. But he also predicted the most fantastic element of all – element X – and said that it could not be isolated because it was everywhere.

The periodic table of the elements, familiar as it may seem today, was perceived by Mendeleev only through extraordinary boldness. To discern periodic patterns, the elements had to be listed in some logical order. Today they are listed in order of atomic number, but in Mendeleev's day they were ordered by atomic weight, and many of these atomic weights were in error. Other scientists had attempted to find patterns, but they were not willing to change the atomic weights that did not fit, nor allow for undiscovered elements. Iodine has a lower atomic weight than tellurium, yet Mendeleev placed iodine after tellurium because it was obviously related to the other elements of the halogen family. Mendeleev felt that such boldness was vindicated when gallium, germanium, and scandium were discovered and had the properties he had predicted.

Mendeleev was also interested in many other topics, and toward the end of his career he began to speculate about the *ether*, a perennial problem of science, which led him to the mysterious element X.

Ether was a hypothetical substance that made up empty space and was the medium through which light traveled. Scientists found it difficult to imagine a wave traveling from one place to another without some vibrating medium. Sound waves, for example, must travel through air, water, or some other substance and cannot pass through a vacuum. It was believed that light waves required a medium as well. Therefore, there had to be a medium, which penetrated solid material such as glass, that filled the space between the stars and transmitted light. That medium – the ether – prove to be undetectable because it passed freely through other substances and was inert.

It was the discovery of the inert gases, in the 1890s, that started Mendeleev thinking about element X. If, by using chemical analogies, he had successfully predicted the existence and properties of elements heavier than hydrogen, why couldn't the same process be used to predict elements lighter than hydrogen? The inert gases, which had long eluded discovery because they didn't react with other elements, provided a model. Helium in particular was known to penetrate liquids and even certain solids. Ether – if it existed must also be inert and able to penetrate other bodies. Could there be an undiscovered, infinitesimally light, inert element that might be the atom of ether? Mendeleev boldly predicted the existence of element X and placed it in the inert gas group in a new period (period 0).

Mendeleev asserted that X was "capable of moving freely everywhere throughout the universe, [with] an atomic weight nearly one millionth that of hydrogen, and traveling with a velocity of about 2250 kilometers per second."

Mendeleev wrote, "Without going into a further development of our subject, I should like to acquaint the reader with some, at first sight, auxiliary circumstances that guided my thoughts and lead me to publish my opinions. These consist of a series of physicochemical phenomena that are not subject to the ordinary doctrines of science.... This more especially refers to radioactive phenomena." He went on to describe his observation of radioactive uranium and thorium in the laboratory of Pierre and Marie Curie. Because uranium and thorium are heavy elements, he reasoned, they might be capable of attracting and 'dissolving' element X. X would then emanate from these heavy elements, manifesting its presence by scintillations on a zinc sulfide screen – a phenomenon common in radioactivity.

Not bad reasoning! But alas, it was wrong. Mendeleev also put forward other faulty ideas.

When the electron was discovered, Mendeleev resisted the concept because electrons were said to come from within atoms. He fought *any* suggestion that atoms might have some internal structure. Atoms, he believed, were unique – not composed of more basic matter. Mendeleev's approach was both scientific and emotional. There just *had* to be a periodic pattern to the elements. Notions about the internal structure of atoms were wrong, he felt, because "No general relation is possible between things unless they have some individual character resident in them." He predicted that the hypothesis of electrons would "in time occupy a position in the history of our science similar to that long ago accorded to phlogiston."

Today electrons are in and ether is out. Is the great man not so great after all? By no means! If it were not for his strong conviction about the uniqueness of elements and their mysterious family relationships, he might not have been so bold as to propose the Periodic Law.

Mendeleev was 'wrong' in another interesting speculation: the origin of petroleum. Geologists believe that petroleum was formed by the decomposition of ancient plants and animals, but Mendeleev asserted that petroleum had a nonbiological origin. He claimed that water, seeping downward through cracks and fissures in the Earth's crust, reacted with carbides of iron in the very hot upper mantle to produce hydrocarbons (much as calcium carbide will react with water to produce acetylene). His hypothesis was ignored. Everyone knew that petroleum came from organic matter. But, in Siberia, oil fields were found in geological formations that are seemingly devoid of previous life.

Recently, scientist Thomas Gold asserted that certain oil deposits were formed from primordial methane that was trapped in the crust during the formation of the earth. Evidence of nonbiological petroleum deposits in Sweden prompted the Swedish government to start exploratory drilling. Interestingly enough, the Russians are now carrying out similar tests. Is it Gold's nonbiogenic theory they are testing – or Mendeleev's?

Tasks to the Text

I. What is this text about?

II. Find key words.

III. Make a graph of the text.

IV. Answer the questions:

1. What do you know about D. Mendeleyev?
2. Is ether an element?
3. What is the origin of petroleum?

V. Put three questions to the text.

VI. Write the summery of the text.

VII. Entitle the text.

Text III

Anders Celsius (1701–1744) was a Swedish astronomer, physicist, and mathematician who introduced the Celsius temperature scale that is used today by scientists in most countries. He was born in Uppsala, Sweden, a city that has produced six Nobel Prize winners. Celsius was born into a family of scientists all originating from the province of Hälsingland. His father Nils Celsius was a professor of astronomy, as was his grandfather Anders Spole, and his other grandfather, Magnus Celsius, was a professor of mathematics; both grandfathers were at the University in Uppsala. Several of his uncles also were scientists.

Celsius's important contributions include determining the shape and size of the Earth; gauging the magnitude of the stars in the constellation Aries; publishing a catalog of 300 stars and their magnitudes; observing eclipses and other astronomical events; and preparing a study that revealed that the Nordic countries were slowly rising above the sea level of the Baltic. His most famous contribution falls in the area of temperature, and the one he is remembered most for is the creation of the Celsius temperature scale.

In 1742 he presented to the Swedish Academy of Sciences his paper, "Observations on Two Persistent Degrees on a Thermometer," in which he presented his observations that all thermometers should be made on a fixed scale of 100 divisions (centigrade), based on two points: 0 degrees for boiling water, and 100 degrees for freezing water. He presented his argument on the inaccuracies of existing scales and calibration methods and correctly presented the influence of air pressure on the boiling point of water.

After his death, the scale that he designed was reversed, giving rise to the existing 0° for freezing and 100° for boiling water, instead of the reverse. It is not known if the reversal was done by his student Martin Stromer; by botanist Carolus Linnaeus, who in 1745 reportedly showed the senate at Uppsala University a thermometer so calibrated; or by Daniel Ekström, who manufactured most of the thermometers used by both Celsius and Linnaeus. However, Jean Christin from France made a centigrade thermometer with the current calibrations (0° freezing, 100° boiling) a year after Celsius and independent of him, and so he may therefore equally claim credit for the existing "Celsius" thermometers.

For years Celsius thermometers were referred to as "Centigrade" thermometers. However, in 1948, the Ninth General Conference of Weights and Measures ruled that "degrees centigrade" would be referred to as "degrees Celsius" in his honor. The Celsius scale is still used today by most scientists.

Anders Celsius was secretary of the oldest Swedish scientific society, the Royal Society of Sciences in Uppsala, between 1725 and 1744 and published much of his work through that organization, including a math book for youth in 1741. He died of tuberculosis on April 25, 1744, in Uppsala.

Tasks to the Text

I. What is this text about?

II. Find key words.

III. Make a graph of the text.

IV. Answer the questions:

1. Anders Celsius specialization was chemistry, wasn't it?
2. Who is Fahrenheit?
3. Do you know the difference between Celsius temperature scale and Fahrenheit temperature scale?

V. Put three questions to the text.

VI. Write the summery of the text.

VII. Entitle the text.

Text IV

It's not often that scientists get to conduct experiments that seem like they come out of a science fiction novel or a video game. Yet, that is what some researchers at NASA did a few years ago.

Atmospheric physicists Paul Newman and Luke Oman built a simulation of the Earth's atmosphere and then proceeded to strip away our protective ozone layer. Their computer model reproduced the chemistry and circulation of the air; natural variations in temperatures and winds; and minor changes in the energy received from the sun. Newman and Oman then added ozone-destroying chemicals to the atmosphere at a rate of 3% more per year – on top of what was already in our 1970s atmosphere. For several months, they ran their model on a supercomputer and reproduced about 80 years of simulated Earth time. They called their experiment **"The World Avoided".**

By the year 2020 in the simulation, 17% of the Earth's protective ozone layer vanished. Holes in the ozone layer formed not just over Antarctica – as they currently do each spring – but over the Arctic, too. By 2040, the ultraviolet (UV) index, the measure of the sunburn-causing radiation reaching the Earth's surface, rose as high as 15 on summer days in mid-latitude cities such as Washington, D.C. (A UV index of 10 is considered very high today and quickly leads to sunburn if you don't wear sunscreen.)

In the simulated future, two-thirds of the planet's ozone layer disappeared by 2065. Ozone holes swirled over both poles all year long, and most ozone disappeared from the tropics, too. The intensity of UV radiation reaching the Earth's surface doubled – levels that would increase DNA mutations in human and animal cells, suppress our immune systems, and increase the incidence of cataracts and skin cancer.

In another demonstration of the effects of a world without an ozone layer, Newman's group exposed a basil plant to intense UV radiation. In a lab at NASA's Goddard Space Flight Center, they set up a special lamp that simulates the intensity of sunlight when testing satellite hardware. They put a basil plant in front of that lamp and a camera behind it and watched for 27 hours. Without the protective shielding of an ozone layer, the plant started browning and developing spots within an hour. It was dead in a day.

"We simulated a world avoided, and it's a world we should be glad we avoided," Newman said.

The experiments run by Newman and colleagues were actually extensions of an experiment that humans have been unwittingly running with Earth for nearly a century. Humans have been depleting the ozone layer with chemical products.

The unintentional experiment started in the late 1920s, when Thomas Midgley Jr. and other industrial chemists began to produce chlorofluorocarbons (CFCs), nontoxic compounds that improved refrigeration. Other manufacturers later put these chemicals to work as propellants in spray cans and as solvents for cleaning greasy residues. CFCs and similar compounds are mostly inert (nonreactive) at sea level and so were found to be extremely useful for all of these tasks.

But the progress came with a cost: People who used CFC products were releasing more chlorine into the environment than could be removed by natural processes. Unknown to the chemists who developed them, CFCs were accumulating and dispersing through the atmosphere. At high altitudes, where conditions are different from the Earth's surface, those chlorine compounds were destroying ozone, the gas that absorbs and scatters UV light from the sun.

Because CFCs are so stable near the ground, it took decades before scientists started seeing signs of this ozone problem higher in the atmosphere. It wasn't until the 1970s that chemists learned that CFCs break into chlorine atoms when exposed to intense UV light from the sun. A chlorine atom can react with ozone to form an oxygen molecule (O_2) and a molecule of chlorine monoxide (*ClO*), and the chlorine atom is 'regenerated' when the chlorine monoxide molecule reacts with another ozone molecule. The chemical reactions are as follows:

$$Cl + O_3 \rightarrow ClO + O_2$$

$$ClO + O_3 \rightarrow Cl + 2\,O_2$$

The net result ($2O_3 \rightarrow 3O_2$) is that one chlorine atom destroys two ozone molecules and is regenerated in the process, allowing it to react over and over again. So, a single chlorine atom can destroy thousands of ozone molecules. And because CFCs are removed very slowly from the atmosphere, their ozone-depleting power persists for decades after they are emitted.

As a result of the widespread use of CFCs in consumer products, the ozone layer became depleted, particularly through a phenomenon that most of us know as 'the ozone hole'. The word 'hole' should not be taken literally; there is no hole in the sky. But the area has significantly less –as much as two-thirds less – protective ozone to shield the Earth's surface.

In the past decade, ozone holes have stretched as much as 29 million square kilometers across the skies over Antarctica. Residents of New Zealand and Australia are warned each year to take precautions from the sun, as the ozone hole can occasionally stretch from the South Pole toward middle latitudes.

Atmospheric ozone can be measured both directly and remotely. Scientists take direct measurements by launching instruments on balloons or by carrying them up on research airplanes. The instruments use chemical reactions or pass UV light through a sample of air to measure the presence and amount of ozone.

Remote measurements of ozone are made from the ground and from space; in either case, the instrument of choice is usually a spectrometer or photometer – a device that measures how gases absorb or emit light. In the 1920s and 1930s, British scientist Gordon Dobson measured differences in UV light wavelengths reaching the Earth's surface. Although the instruments have been modernized, the basic premise of Dobson's work continues to this day. The most common unit of measurement for atmospheric ozone levels – known as the Dobson unit (DU) – was named in his honor.

Scientists first became aware of the depletion of the ozone layer in 1985, when British researchers in Antarctica were measuring the amount of ozone in the skies above. They found that ozone levels seemed lower in September, October, and November than at other times of the year. They compared their measurements to data collected every year since 1957 and found less ozone in the 1980s compared to earlier years.

At the same time, scientists at NASA's Goddard Space Flight Center were examining satellite measurements of unusually low ozone over Antarctica. After the British scientists published their results, the NASA scientists published images of an ozone low over Antarctica that was as large as the continent. The term 'ozone hole' was soon coined to describe the seasonal decrease in the UV blocking gas.

Satellite measurements of the ozone layer have been collected for nearly 35 years. Starting with the Total Ozone Mapping Spectrometer, NASA engineers and scientists have developed successive instruments onboard satellites, airplanes, the space shuttle, and the International Space Station to determine the amount of ozone in the air. For the past decade, the workhorse for ozone measurements has been NASA's Aura satellite and its Ozone Monitoring Instrument (OMI), which has extended and improved upon more than 30 years of observations. The recently launched Suomi National Polar-Orbiting Partnership satellite carries a successor to the OMI instrument that is continuing the record of observations.

Piecing together clues from the laboratory and real-world observations, scientists eventually explained to politicians and chemical manufacturers why we needed to stop the production of ozone-depleting substances such as CFCs. The conversation led to an international agreement in 1987 known as the Montreal Protocol on Substances that Deplete the Ozone. Leaders with different political ideologies came together to create a model for global solutions to environmental problems. Many experts have called it the most successful treaty in the United Nations' history.

The 1987 treaty set timelines for countries to reduce and eventually phase out the manufacture and sale of CFCs and other ozone-depleting chemicals. Motivated by the protocol, chemists, engineers, and manufacturers eliminated chlorine from most refrigerants and developed new chemicals that break down faster and lower in the atmosphere. The economic and environmental impact of the change from CFCs has been minimal so far.

While nations agreed to stop depleting ozone, nature will need time to catch up. CFCs are relatively stable and long-lived compounds, and it will take a significant amount of time – estimated at 50–100 years – for the chemicals released years ago to decay in the atmosphere. In fact, the worst global ozone losses and largest ozone holes occurred more than 15 years after the Montreal Protocol was signed.

The numbers tell the story of a changing atmosphere. In 1979, when scientists were just coming to understand that atmospheric ozone could be destroyed, the ozone hole over Antarctica was 1.1 million square kilometers, with a minimum ozone concentration of 194 Dobson Units (DU). In 1987, the area of the hole reached 22.4 million square kilometers and ozone concentrations dropped to 109 DU. By 2006, the worst year for ozone depletion, the numbers were 29.6 million square kilometers and just 84 DU. By September 2012, the hole stretched 21.2 million square kilometers and measured 124 DU – the smallest hole since 2002.

As the Antarctic ozone hole has stabilized, there have been other promising signs. In the past decade, researchers found that the amount of ozone-depleting chemicals in both the lower and upper atmosphere reached a peak around 2000 and has been slowly declining. From the 1980s to the early 2000s, global levels of stratospheric ozone also dipped by 5% to 6%, but they have been rebounding slightly in the past few years.

Still, the experiment is not over. Ozone recovery is uneven, as the size of the hole still varies from year to year depending on weather conditions. In 2011, even though global CFCs were in decline, Arctic ozone fell to a historic low level, due to unusual weather that allowed for greater than usual chemical ozone destruction. Although global warming and ozone depletion are caused by different gases, scientists have shown that a warming planet may change how the stratosphere – and, therefore, the ozone layer – works.

We seem to have avoided a future where there is no protective ozone. But our atmosphere is still vulnerable, and it is not clear whether the ozone layer of the future will look like the ozone layer we had in the past. It will take generations before we know how experiment turned out.

Tasks to the Text

I. What is this text about?

II. Find key words.

III. Make a graph of the text.

IV. Answer the questions:

1. What is ozone?
2. How was a hole in the atmosphere found and how is it studied?
3. How will the ozone experiment turn out?

V. Put three questions to the text.

VI. Write the summery of the text.

VII. Entitle the text.

Text V

Imagine a doctor injecting a patient with tiny devices that can rove the body in search of cancer cells or disease-causing bacteria. Such devices would deliver medicine targeted specifically to a diseased organ or to the bacteria.

Though still years away scientists are trying to make such a scenario possible through nanotechnology, a hot research area in which scientists use atoms and molecules to build materials that can be used in many areas, such as health care, clean energy sources, and shrinking electronics.

These ‘nanomaterials’ measure between 1 and 100 nanometers. Derived from ‘nanos’ – the Greek word for ‘a small person’ – a nanometer is 1 billionth of a meter. In comparison, a strand of hair is roughly 100,000 nanometers wide.

One of the main appeals of nanomaterials is that they have different properties than everyday materials. For example, they do not melt at the same temperature as everyday materials and do not conduct electricity like everyday materials.

These different properties are due to an increase in the surface area of nanomaterials and to their unusual shapes – such as tubes and hollow balls – which can affect how durable they are, how they conduct electricity and heat, and how they absorb light.

An essential part of the nanotechnology toolkit is a tiny cylinder, called a nanotube, which has attracted widespread attention since the early 1990s. A nanotube is basically a sheet of pure, carbon graphite rolled into a cylinder. Nanotubes are usually a few nanometers in diameter and between 1 and 100 micrometers – 1 thousandth of a millimeter – in length.

In an individual graphite layer, called graphene, carbon atoms form a series of six-sided hexagons next to one another. So, when a graphene sheet is rolled up to form a tube, the tube's wall is made of carbon hexagons. The hexagons can be parallel to the axis of the tube or form a helix that winds along the tube.

A nanotube's diameter and how the hexagons are arranged on the wall affect the way nanotubes conduct electricity, making them useful for making electronic components much smaller than those currently used. Also, these tiny tubes are lighter and stronger than steel so they could make good body armor. Research from Alan Windle, a professor of materials science at the University of Cambridge, United Kingdom, suggests that carbon nanotubes in the shape of long, yarn-like fibers could outperform even the strongest bullet-proof materials on the market.

Solid rods of silicon or other materials that are only a few nanometers wide are called nanowires. A nanowire's length is much longer than its width and it behaves like a wire in which electrons can move, thus conducting an electric current.

Nanowires have shown potential applications in solar cells, which harvest the sun's energy and turn it into electricity more efficiently than present solar cells. Also, researchers have used nanowires to build sensors that can detect disease-triggering molecules in the body or harmful chemicals in the air.

Another important structure used extensively in nanotechnology is called a fullerene or 'buckyball'. This hollow soccer ball-shaped molecule is made of 60 carbon atoms, each carbon atom bonded to three adjacent carbon atoms. The sphere is about 1 nanometer in diameter. Other existing buckyballs contain either 70 or 80 carbon atoms.

Several academic laboratories and companies are developing modified buckyballs for therapeutic uses. Luna Innovations, a company based in Roanoke, Va., that develops products for the health care, telecommunications, energy, and defense markets, is testing buckyball-based therapeutics to block inflammation, swelling, and pain associated with medical conditions, such as allergies, arthritis, and wound healing.

This technology is based upon the buckyballs' unique ability to trap harmful free radicals, which increase inflammation and can damage or kill cells. Free radicals are molecules that have an uneven number of electrons. Some free radicals form as part of an immune response targeting viruses and bacteria. Environmental factors such as pollution, radiation, cigarette smoke, and herbicides may create free radicals, too.

The unpaired electron makes free radicals highly reactive. To become stable, free radicals seek to pair that lone electron by taking an electron from another molecule. When this molecule loses its electron, it becomes a free radical itself. This chain reaction ultimately damages the cell when the body cannot cope with too many free radicals.

Luna Innovations has shown that buckyballs can neutralize a dangerous free radical when its unpaired electron is transferred to the buckyball forming a bond. When tested in human-cell culture experiments and mice, Luna Innovations found the buckyballs blocked allergic response.

Scientists are turning to nanotechnology to solve other health care issues. For instance, the standard pill that is swallowed does not efficiently get a drug to the right place and in the right amount. It releases a drug quickly, but its concentration rapidly decreases in the body. So, patients need to take medication often.

Tejal Desai, of the University of California at San Francisco, is developing a better way to deliver medicines to the body. Her group has designed a microchip with nanometer-sized channels that will be able to steadily release a drug over time.

By using pores as small as 7 nanometers in diameter, the scientists observed constant release for tiny molecules of glucose. The steady release of the glucose molecules over time is a result of the tiny size of the nanochannels, which limits how fast the molecule can be released.

Then there are other obstacles to overcome in drug delivery. A good oral drug delivery vehicle has to survive extreme acidity and digestive enzymes as well as mechanical agitation in the stomach, and transfer the drug across a mucous layer, which is meant to keep out foreign invaders, such as pathogens.

"If you can prolong the residence time of a drug or a drug carrier at the site of interest, and if you can improve the contact between the drug-delivery device and your absorbing surface, you can increase the amount of drug available to the body," Desai says. To accomplish this, she and her team have created a flat delivery device which is able to dock on the intestinal wall and release drug through it. This way, most of the drug goes to the targeted area.

Buckyballs have high potential for drug delivery. This approach involves attaching drug molecules to the carbon atoms on the surface of the buckyball. Other chemical groups are added to make the molecules water-soluble. This allows the medicine loaded buckyball to be absorbed by the bloodstream when swallowed or injected. The buckyball can then release the drug upon reaching a chemical trigger, such as a change in pH or a particular chemical substance, such as those released by cancer cells.

Though the potential for nanotechnology is great, there are still many hurdles to overcome before nanomaterials and nanomachines become part of everyday life. One important challenge is creating better manufacturing methods. Creating large quantities of nanoscale materials is still time-consuming and expensive.

"It's like trying to make things out of Lego blocks with boxing gloves on your hands," says Ralph Merkle, senior research fellow at the Institute for Molecular Manufacturing, Palo Alto, Calif.

The next step will be to take the gloves off and develop methods of snapping atoms together. New technologies will have to be developed to safely and reliably do so, and standards and measurements will need to be created to ensure the quality of the resulting nanomaterials.

Along with the promise to improve the quality of life, nanotechnology still holds many unknowns. While the basic research is conducted by scientists and engineers, several programs are looking at the possible societal and ethical impacts of nanotechnology. Others are testing the safety of exposing our environment and our bodies to nanomaterials.

For instance, mice and fruit flies have been exposed to carbon nanotubes with mixed results. In one study, mice were injected with water-soluble carbon nanotubes. Kostas Kostarelos, a professor of pharmacy at the University of London’s School of Pharmacy, and colleagues found that the nanotubes were harmlessly excreted intact inurine. Other studies have found that inhaled nanotubes can accumulate in the lungs and cause inflammation.

Since the data is limited and many more studies are necessary to help determine the real risks of nanomaterials, the U.S. Congress has stepped into the field. Earlier this year, the U.S. House of Representatives passed a bill that requires federal agencies participating in the National Nanotechnology Initiative – a program established in 2001 to coordinate nanotechnology research among various federal agencies – to develop a plan for environmental and safety research. A similar bill is expected in the U. S. Senate soon. While the safety debate continues, scientists will forge ahead in their search for nanotechnology solutions to life’s challenges.

There are basically two ways to build nanomaterials. Researchers can modify a starting material much like an artist shapes a sculpture from a slab of marble, adding to it and taking material away from it. With this method, called the ‘top-down’ approach, a material is altered by mechanical or chemical means.

An electron beam or light are usually used to create these incredibly small structures. The techniques are called electron beam lithography and photolithography, respectively. In electron beam lithography, a focused beam of electrons forms the circuit patterns needed for depositing material on or removing material from a surface. In contrast, photolithography uses light for the same purpose.

Photolithography is limited in the size of the patterns it creates by the wavelength of visible light, which range between 400 nanometers and 700 nanometers. Narrower features can be made by using ultraviolet light with shorter wavelengths, between 380 nanometers and

10 nanometers, which is more expensive. In contrast, electron beam lithography produces patterns in the order of 20 nanometers but takes longer and is expensive.

Alternatively, the ‘bottom-up’ approach starts with individual molecules or atoms and brings them together to form a product in which every atom is in a designated location. Often molecules are designed and created so that they can spontaneously self-assemble when a chemical or physical trigger is applied. An example of this in nature is the formation of a double strand of DNA, the genetic material in every cell.

Weak interactions play an important role in bottom-up manufacturing. These bonds can be made and broken much more easily than the covalent bonds that bind most atoms in molecules.

Although bottom-up processes are less developed and understood, they hold great promise for the future, because they lead to a wider variety of structures. In practice, both top-down and bottom-up methods are useful and being actively pursued, but the ultimate goal of building products with atomic precision will require a bottom-up approach. Some scientists foresee a day when nanomachines will be programmed to replicate themselves, or to work synergistically to build larger machines.

Tasks to the Text

I. What is this text about?

II. Find key words.

III. Make a graph of the text.

IV. Answer the questions:

1. Where nanotechnology can be used?
2. What is the difference between nanowires and nanoballs?
3. Is it easy to apply nanotechnology in practice?

V. Put three questions to the text.

VI. Write the summery of the text.

VII. Entitle the text.

References

1. ChemMatters, Joseph D. Ciparick, www.acs.org/chemmatters. – December,1987. – Pp. 8-9
2. ChemMatters, Mike Carlowicz, www.acs.org/chemmatters. – April, 2013. –Pp. 12-14
3. ChemMatters, Nadia Halim, www.acs.org/chemmatters. – October 2009. – Pp. 15-17
4. Rittner, Don, Bailey, Ronald A. Encyclopedia of Chemistry.–Facts On File, Inc.–New York, 2005. – 342 p.