МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
Відкритий міжнародний університет розвитку людини «Україна»

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PROFESSIONAL ENGLISH FOR CHEMISTS

Handbook
for studying and using English
for students of engineering and biomedical specialties

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ПРОФЕСІЙНА АНГЛІЙСЬКА ДЛЯ ХІМІКІВ

посібник
для вивчення і використання англійської мови
для студентів інженерних та біомедичних спеціальностей

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For students of engineering and biomedical fields. Students will be able to use the guide for self-study.

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CONTENTS

UNIT 1
EDUCATION IN UKRAINE

Exercise 1. *Learn the following words and word combinations:*

well-known scientist - відомий вчений
state figure - державний діяч
electrical engineering - електротехніка
material science - матеріалознавство
computer science - інформатика
to take pride in smth - пишатися
graduate - випускник
to emerge - виникати, з'являтися
to make a considerable contribution to smth - робити значний внесок
scientific and academic activities - наукова та навчальна діяльність
power - енергетика
the humanities - гуманітарні дисципліни
ecological safety - захист довкілля
extramural training - заочне навчання
subdivision - підрозділ
preparatory department - підготовче відділення
research institute - науково-дослідний інститут
training (educational) process - навчальний процес
state prize - державна премія
profound knowledge - глибокі знання
amateur art activities - художня самодіяльність
to be in favour - користуватися успіхом

Exercise 2. *Make a "map" of your knowledge about The Open International University of Human Development "Ukraine". Answer the questions: What do I know about: 1) the history of the University; 2) the number of students and teaching staff; 3) the institutes the University includes; 4) modern facilities the University has; 5) the institute I study in.*

Exercise 3. *Read and translate the text.*

The Open International University of Human Development "Ukraine"

The Open International University of Human Development "Ukraine" the only higher educational institution of an integrated type which is open for young people of unequal level of preparation differentiated social opportunities and different state of health. It

consciously undertook the mission of teaching people with the special needs. This is its uniqueness. The mission of the Open International University of Human Development "Ukraine": high-quality accessible higher education for people seeking full personal self-realization in the public interest. The goal of the Open International University of Human Development "Ukraine": the provision of higher education to all comers, including young people with special needs, through the introduction of advanced educational technologies. The goals of the Open International University of Human Development "Ukraine": the creation and organization of a system of training and retraining of specialists of various skill levels in the field of market economy, the sphere of social and legal support, financial and economic activities of enterprises and institutions, primarily from the disabled and persons with limited opportunities, especially those affected by the Chernobyl disaster, local conflicts, wars and emergencies; The development in the learning process of rehabilitation methods for the disabled; Adaptation of university graduates to specific production conditions through the creation of an integrated institution (training and production complex), on-going training, research, consulting and mediation.

The main tasks of the Open International University of Human Development "Ukraine" are:

- Mobilizing the capacities of state, municipal, private and departmental institutions and educational institutions, production structures, public organizations, foundations and individuals to form a scientific, educational and rehabilitation base for training and production and retraining of specialists, First of all - from among disabled people;
- Creation, selection and implementation of such teaching methods and technologies that would ensure the combination of the educational process with production activities, scientific research and activities to adapt specialists to a full-fledged life, and study modern methods of management and entrepreneurship;
- Assistance in retraining and constant improvement of the professional level of the entire able-bodied population of Ukraine;
- The creation of a scientific and methodological information center for coordinating the activities of regional and sectorial educational institutions, as well as for research in the direction of cooperation and adaptation of disabled people in the educational and production sphere;
- Introduction of distance learning technologies for the entire population of Ukraine;

– Carrying out of fundamental and applied scientific researches on humanitarian, natural, technical and other directions of science and culture.

The Open International University of Human Development "Ukraine" conducts research work, identifies areas of priority scientific research, established scientific schools, operates the Center of High Technologies, which includes 6 research institutes and departments. To dramatically improve the quality of education, there are university-wide scientific and methodological associations, a powerful publishing and printing complex and an own audio and video studio that are engaged in the production of educational and methodological support. Cooperation has been established with Ukrainian, foreign and international institutions and educational institutions.

Exercise *4. Answer the following questions.*

1. When was the university founded? 2. What kind of specialists has it been training since its foundation? 3. What powerful scientific schools have been founded at the university? 4. Who is the present rector? 5. How many and what institutes train specialists at present? 6. What faculties do they have? 7. What other educational institutions are incorporated in the university? 8. How many students study at the university now? 9. What is the university teaching staff known for? 10. What facilities are used in the training process at the university?

Exercise 5. *Translate into English.*

1. Багато спеціалістів, які працюють в Україні, пройшли підготовку у Відкритому міжнародному університеті розвитку людини «Україна». 2. Багато випускників продовжують працювати в рідному університеті, примножуючи його славу. 3. До навчального процесу в університеті залучаються провідні фахівці промислових підприємств. 4. Університет надає великого значення ролі художньої самодіяльності в організації студентського довкілля.

Exercise 6. *Work in pairs and make up a dialogue on the topic:* I *am a student of the Open International University of Human Development "Ukraine" using the following words and word combinations.*

first-year student	be expelled from the University
second-year student / freshman	cheat

full-time student	disrupt classes
part-time student	swot
inaugural ceremony	swotter
audience hall	miss classes
student identity card	skip/ go skiving
attend classes	skiver
attendance is compulsory	be late for classes
check students' coming in time	take exams
be given a good talking	pass exams

Exercise 7. *Imagine that you are a member of the international educational organization. Your task is to advertize the Open International University of Human Development "Ukraine" to the students from different countries. Work in pairs and make a short concise presentation on the topic.*

Exercise 8. *Put the paragraphs in the right order. Give the title to the text. Add more information on the topic.*

(A) Education in Ukraine is given a great attention by the government and a large number of facilities and institutions exist for the purpose of educating the population. The system of education in Ukraine extends right from pre-school to higher education.

(B) Basic school also falls under the secondary education system in Ukraine. This is the students' last level of formal basic education. This level of education provides the link to continuous education systems. It is compulsory to attend basic school for five years. Formal basic education is completed between the ages of 14 and 16 years. On completion of basic schooling the student will receive a certificate allowing them to continue on to upper secondary school as well as certain higher education institutions.

(C) Ukraine has a very well-developed higher education system. Higher education is provided by higher education establishments, private bodies and scientific and methodological facilities of the government. This system also encompasses post-graduate programs and Ph.D's as well as self-education. The levels of accreditation depend on the Higher Education Institutes' status.

(D) Ukraine's educational legislation places great importance on

preschool education. This early form of education is to be cared for by the family or through a pre-school institution. A variety of institutions is available for this level of education in Ukraine and includes day care centers, kindergartens and special facilities for disabled children. Provision is also made for orphans.

(E) Level one includes vocational schools that train junior specialists. Level two are colleges and similar organizations that teach bachelors. Level three is made up of universities, institutes, academies and conservatories which provide education for bachelors and specialists. Level four includes universities, conservatories, institutes and academies which educate bachelors, specialists and masters.

(F) It is evident that the system of education in Ukraine has been well-developed and opportunities exist for the entire population, even those living in the rural areas.

(G) Elementary school education in Ukraine forms the foundation of a child's schooling career. Ukraine's Law on Education states that provision of elementary schools must be made wherever there are students. Elementary or primary education acts to develop children's personalities, talents, formation of morals, working education as well as knowledge of the human body, nature, industry and society. This level of education is compulsory in Ukraine and is available at various types of institutions. Students begin secondary comprehensive schooling at the age of 6 or 7 years.

Exercise 9. *Develop the ideas.*

1. Elementary school education in Ukraine forms the foundation of a child's schooling career.
2. Ukraine has a very well-developed higher education system.
3. Ukraine is one of the best platforms for education, business and tourism.
4. In today's world the urge to take admissions in Medical and Engineering Universities and Colleges is getting high among the students.
5. Higher education within the Ukrainian community has always been open to foreign students.
6. The National Academy of sciences, higher educational institutions of Ukraine maintain broad international contacts.
7. Ukraine is distinguished by a high level scientific potential.
8. The Ukrainian educational system is organised into five levels: preschool, primary, secondary, higher and postgraduate education

UNIT 2
EDUCATION IN GREAT BRITAIN AND THE USA

Exercise 1. *Learn the following words and word combinations:*

government - уряд
to commit - схилятися, мати намір
trading nation - торгівельна нація
intense international cooperation - напружена міжнародна співпраця
needs of the economy - потреби економіки
emphasis - наголос
vocational course - професійний напрям
virtually - фактично
selective - вибірковий
teacher education - педагогічна освіта
method of instruction - метод навчання
school leaver - випускник
typing - друкарство
town planning - міське господарство
to attend lecture - відвідувати лекцію
to keep in touch - бути на зв'язку
tutor - наставник, вихователь, керівник
to place a high value - надавати великої цінності
to maintain - утримувати
to comprise - охоплювати
to seek a bachelor's degree - здобувати ступінь бакалавра
to transfer to - переводити до
source of funding - джерело фінансування
income - дохід
student tuition - плата за навчання
endowment - пожертва
public-tax money - гроші платників податків
curriculum - програма
to complete assignment - виконувати завдання

Exercise 2. *Read and translate the text and make a comparative table of higher education in the UK and Ukraine.*

Higher Education in the UK

The British Government is committed to improving education and training for 16- to 19-year-olds and considers that a high level of cooperation between the education system and business is necessary to

maintain Britain's position as a leading industrial and trading nation. Rapid technological change and intense international cooperation mean that education must be closely matched to the needs of the economy. More emphasis is being given to science, engineering, technology and vocational courses.

Higher education in England has several branches: colleges of education that mostly prepare students to be teachers, polytechnics that usually prepare students for some kind of career and universities. Virtually all higher education is selective, usually depending on how well a student does in GCE, "A" level (the General Certificate of Education, "Advanced" level). However, good exam results alone are not enough. Universities choose their students after interviews. For all British citizens a place at a university brings with it a grant from their local education authority.

The academic year in Britain's universities, Polytechnics, Colleges of Education is divided into three terms, which usually run from the beginning of October to the middle of December, from the middle of January to the end of March, and from the middle of April to the end of June or the beginning of July.

After three years of study, university graduates will leave with the Degree of Bachelor of Arts, Science, Engineering, Medicine etc. Later they may continue to take a Master's Degree and then a Doctor's Degree. Research is an important feature of university work. The Polytechnics like the universities offer first and higher degrees. Colleges of Education provide two-year courses in teacher education or sometimes three years if the graduate specializes in some particular subject.

There are 46 universities in Britain. The oldest and best-known universities are located in Oxford, Cambridge, London, Leeds, Manchester, Liverpool, Edinburgh, Southampton, Cardiff, Bristol, and Birmingham. English universities greatly differ from each other. They differ in dates of foundation, size, history, traditions, general organization, methods of instruction, and students' way of life.

Some school leavers choose to go to a further education college where they can follow a course in typing, engineering, town planning, cooking or hairdressing, full-time or part-time. Further education colleges have strong ties with commerce and industry. There is an interesting form studies, which is called the Open University. It is intended for people study in their own free time and who attend "lectures" by watching, television and listening to the radio. They keep in touch by phone or letter with the tutors and attend summer schools.

Exercise 3. *Answer the following questions to the text.*

1. Why is the British Government committed to imp education? 2. What branches does higher education in England 3. What careers are students trained for? 4. What is implied by- education in Britain is selective"? 5. What is the academic year universities like? 6. What degree will a university graduate leave after three years of study? 7. What is the duration of the teacher-t provided at Colleges of Education? 8. What is the Open University?

Exercise 4. *Give Ukrainian equivalents:*

To be committed to; to maintain position; to give emphasis commercial application; to do well in; to take a Master's Degree; to offer first and higher degrees; to provide two-year courses in; to specialize in some particular subject; to go to a further education college; to folio course in typing or engineering full-time or part-time; to attend "lectures" watching television; to keep in touch by phone.

Exercise 5. *Read the text and put* 7 *special questions to the text.*

The Universities of Oxford and Cambridge

The oldest universities of Oxford and Cambridge were founded the two towns towards the end of the twelfth century. The story of I University in Cambridge begins in 1209 when several hundred students a scholars arrived in the little town of Cambridge. These students were churchmen and had been studying in Oxford, at the city of well-kno« schools.

There were many quarrels with the townsfolk, for the Univers wanted to be independent of the Town. Side by side with the fight freedom from Town rule and another for liberty from Church rule University became its own master at last in 1500. Now at Oxford a Cambridge the colleges are self-governing institutions.

In those early days student life was very different from what it now. Students were of all ages and came from everywhere. The stude were armed; some robbed the people of the countryside.

Students were forbidden to play games, to sing (except religious hymns), to hunt or fish, or even to dance. All the lessons were in the Latin language which students had to speak even among themselves.

Many great men studied at Cambridge and Oxford, among them Bacon the philosopher, Milton the poet, Newton the scientist, and John Galsworthy the writer.

The universities have their own traditions, which they preserve carefully. A student must wear a cap and gown - it is a custom from the

time when students were clergymen. If a student disobeys this regulation he must pay a fine. Students correctly dressed have their meals in the College dining room and mustn't be late for dinner. Sporting activities are very numerous and popular there.

Exercise 6. *Match the entries of the left-hand column with their Ukrainian equivalents in the right-hand column:*

place a high value	можливості для досліджень
seek a degree	доступ до комп'ютера
transfer to a university	державні установи
source of funding	високо цінувати
clear distinction	перевестись до університету
student tuition	здобувати ступінь
endowment	джерело фінансування
benefactor	приватні навчальні заклади
public institutions	прийняття, внесення до списку
private institutions	вклад, пожертва
access to a computer	чітка відмінність
complete assignments	плата за навчання
enrollment	виконувати завдання
research facilities	доброчинець, благодійник

Exercise 7. *Translate the sentences into English.*

1. У Великобританії існують державні школи (безкоштовні) і приватні (платні), в яких навчається до 10% учнів. 2. Провідні місця в системі освіти займають приватні школи, які відрізняються більш якісною підготовкою. 3. В Англії широкої популярності набули школи- пансіони, де студенти живуть і навчаються. 4. Рейтинги шкіл, як правило, визначаються результатами екзаменів випускників, на які звертають увагу під час вибору школи. 5. Превагою освіти Великобританії є високий викладацький рівень. 6. Сувора атмосфера приватних шкіл та шкіл-пансіонів не відволікає студентів від вивчення предметів, а лише сприяє бажанню досягати високих цілей.

Exercise 8. *Read and translate the following text.*

Higher Education in the United States

The United States leads all industrial nations in the proportion young men and women who receive higher education. Americans place high value on higher education. This attitude goes back to the country's oldest political traditions. People in the United States have always believed that education is necessary for maintaining a democratic government Besides, for some careers - law, medicine, education, and engineering: college education is a necessary first step.

The system of higher education in the United States is complex, comprises four categories of institutions: (1) the university which mi contain several colleges for undergraduate students seeking a bachelor's (four-year) degree and one or more graduate schools for those seeking master's or a doctoral degree; (2) the four-year undergraduate institution - the college - most of which are not part of a university; (3) the technical training institution providing courses from six months to four years in duration an training students in a variety of skills, from hair styling through business accounting to computer programming; (4) and the two-year or community college from which students may enter many professions or may transfer to four-year colleges or universities.

Depending on the source of its funding any of these institutions mi be either public or private, there being no clear distinction in terms of quality of education offered. However this is not to say that all institutions enjoy equal prestige or that there are no material differences among them. Both public and private colleges depend on three sources of income: student tuitions, endowments (gifts made by wealthy benefactors) and government funding. Some endowments are very large: Harvard, Princeton, Yale Universities have more than a thousand million dollars each. Public institutions receive a larger portion of public-tax money than do private schools.

In an American university, each college and graduate school has own curriculum. At the undergraduate level there may be some courses that a student has to take (e.g. classes in world history, math, writing or research). But students do select their "major" (the field in which they want their degree), plus a number of "electives"(courses that are not required but that students may choose). Typically, an undergraduate student has to earn certain number of "credits" (about 120) in order to receive a degree at end of four years of college. Credits are earned by attending lectures (or lab classes) and by successfully completing assignments and examinations.

Exercise 9. *Answer the following questions to the text.*

1) Why do Americans place high value on higher education? 2) Why do they try to learn in advance about entrance requirements and the degrees offered? 3) What does the system of obligatory, major and elective courses mean? 4) Why are they interested if a college or a university is a public institution or a private one? 5) Why do they try to get information about how large the school is? 6) Why do students seek the most respected universities?

Exercise 10. *Complete the sentences.*

1. The United States leads . . . . 2. Americans place a high value on ... . 3. People in the United States have always believed that ... .4. The system of higher education in the United States is ... . 5. The system of higher education comprises ... .6. Depending on the source of funding . . . . 7. Each college and graduate school has its own ... . 8. Typically, an undergraduate student has to earn a ... 9. The system of higher education ...

Exercise 11. *Compose your own sentences with the following word combinations.*

to place a high value	Benefactor
to seek a degree	public institutions
to transfer to a university	private institutions
source of funding	access to a computer
student tuition	to complete assignments
endowment	research facilities

Exercise 12. *Comment upon the statements.*

3. 1. No man is born wise or learned. 2. If a thing is worth doing at all it is worth doing well. 3. Some read to think - these are rare; some to unite - these are common; and some to talk, - and these form the great majority. 4. Science is organized knowledge. 5. By doing nothing we learn to do ill. 6. Learning without thought is labour lost, thought without learning is perilous (dangerous).

Exercise 13. *Match the beginnings of the sentences with their endings.*

1. There is no national system of	A) by the adaptation of two traditions: English and Continental.
2. These institutions may be	B) as small as 15 or 20 students.
3. American higher education developed its own pattern	C) nine months duration, or two semesters of four and a half months
4. The methods of instruction in the universities are	D) the lecture method.
5. The academic year is usually of	E) higher education in the USA.
6. During one term or semester, a student will study	F) four or five different subjects.
7. The students' progress is often evaluated	G) small or large, rural or urban, private or public, etc.
8. Much instruction is provided by	H) the lecture, discussion and work in] laboratory or seminary.
9. In some colleges, lecture groups might be	I) through quizzes, term papers, and a final examination in each course.

Exercise 14. *Distribute the following words according to the part of speech into separate groups; define their suffixes where possible; translate them.*

Those, engineering, among, its, wealthy, and, contain, typically from, oldest, this, benefactor, of, thousand, may, variety, enrollment, for access, million, transfer, endowment, in, enjoy, equal, industrial, no, four about, public, duration, source, be, institution, higher, successfully.

Exercise 15. *Translate into English.*

1. У Сполучених Штатах немає єдиної державної системи освіти і суворих стандартів для навчальних закладів. 2. Кожен штат визначає структуру та обсяг системи освіти. 3. Система освіти І Америці поділяється на кілька рівнів: початкову, середню, вищу в дипломну.

9. Всі навчальні заклади діляться на приватні і державні. 5. 1 державних школах навчання безкоштовне, а в державних коледжах!

університетах є платним. 5. Крім державних шкіл в США є велич кількість приватних шкіл, в яких навчається більше 15% учнів 6. Приватні школи, як правило, утримуються за рахунок плати за навчання. 7. Навчання в приватних школах коштує більше 2000 $ на рік і дозволити собі можуть лише заможні громадяни. 8. Більшість учнів приватних шкіл стають дипломатами, чиновниками та керівникам. 9. Перевагою навчання в США є хороша сучасна матеріальна база і добре організовані навчальні та наукові процеси.

Exercise 16. *Develop the ideas.*

1. Education is the key to the future of any country.
2. Countries have lifted themselves out of poverty through education.
3. The educational system should teach kids to strive for perfection, not congratulates them for getting mediocre marks.
4. A lot of kids look down and sneer upon those who are doing well in school.
5. The creation of the world's first system of universal public education and of mass higher education is one of the great achievements.

Exercise 17. *Compare the educational system in three countries: Ukraine, Great Britain and the USA. Make the presentation and show your results.*

UNIT 3
THE HISTORY OF CHEMISTRY

Exercise 1. *Learn the following words and word combinations:*

ancient civilization - древня цивілізація
branches of chemistry - галузі хімії
to extract metal from ore - добувати метал із руди
pottery and glaze - кераміка та глянс
to dye cloth - фарбувати тканину
to tan leather - дубити шкіру
to render fat into soap - топити жир на мило
arguably - суперечливо
mystical force - містична сила
to light habitat - освітлювати оселю
to coincide with - збігатися, співпадати з
purification of metals - очищення металів
to seek (sought, sought) - шукати, прагнути
precious metal - дорогоцінний метал
heyday - розквіт
armor and weapon - лати та зброя
significant progress - значний протре
philosopher's stone - філософський камінь
protoscience - перша наука
bubonic plague - бубонна чума
eternal youth - вічна молодість
full-fledged science - розвинута наука
law of conservation of mass - закон збереження маси

Exercise 2. *Read, translate the text and make the plan of the text.*

The Beginning of Chemistry

Who can now imagine one's life without chemistry? It is everywhere around us. However, when were the first attempts to study chemic character of surrounding nature made?

By 1000 BC, ancient civilizations used technologies that would eventually form the basis of the various branches of chemistry. Examples included extracting metals from ores, making pottery and glazes, fermenting beer and wine, making pigments for cosmetics and painting, extracts chemicals from plants for medicine and perfume, making cheese, dying cloth, tanning leather, rendering fat into soap, making glass, and making alloys like bronze.

Arguably, the first chemical reaction used in a controlled manna was fire. However, for millennia fire was simply a mystical force that could transform one substance into another (burning wood, or boiling water) while producing heat and light. Fire affected many aspects of everyday life: cooking, habitat lighting, pottery, bricks, melting of metals to make tools etc.

Later there were made numerous attempts to identify a small number of primary elements that make up all substances in nature. Substances lilt air, water, and soil/earth, energy forms, such as fire and light, and more abstract concepts such as ideas, ether, and heaven, were common in ancient civilizations; for example Greek, Indian, Mayan, and ancient Chine« philosophies considered air, water, earth and fire as primary elements.

Even atomism can be traced back to ancient Greece and ancient India. Greek atomism dates back to 440 BC, Democritus and Leucippus declared that atoms were the indivisible part of matter. This coincided with a similar declaration of Indian philosopher Kanada in his Vaisheshika sutras around the same period.

It was fire that led to the discovery of glass and the purification of metals, which in turn gave way to the rise of metallurgy. During the early stages of metallurgy, methods of purification of metals were sought, and gold, known in ancient Egypt as early as 2600 BC, became a precious metal. The discovery of alloys heralded the Bronze Age. Countries in Eurasia had their heyday when they made the superior alloys, which, in turn, made better armor and better weapons. Significant progress in metallurgy and alchemy was made in ancient India.

Many people were interested in finding a method that could convert cheaper metals into gold. The material that would help them do this was rumored to exist in what was called the philosopher's stone. This led to the protoscience called alchemy. Alchemy was practiced by many cultures throughout history.

Alchemy did not only tried to turn base metals into gold, but especially in Europe rocked by bubonic plague, there was hope that alchemy would lead to the development of medicines to improve people's health, to find the elixir of life, which promised eternal youth. Neither the elixir nor the philosopher's stone were ever found.

Early attempts to explain the nature of matter and its transformations failed. Alchemy was also unsuccessful in explaining the nature of matter. However, by performing experiments and recording the results the alchemists set the stage for modem chemistry. This distinction

began to emerge when Robert Boyle made clear differentiation between chemistry and alchemy. Chemistry then became a full-fledged science when Antoine Lavoisier developed his law of conservation of mass, which demanded careful measurements and quantitative observations of chemical phenomena. So, while both alchemy and chemistry were concerned with the nature of matter and its transformations, it is only the chemists who applied the scientific method.

Exercise 3. *Answer the following questions.*

1. What formed the basis of the various branches of chemistry?
1. What were the technologies used by ancient civilizations by 1000 BC?
2. What was the first chemical reaction used in a controlled manner?
3. What were the functions of fire for ancient civilizations?
4. What was believed to be the primary elements that make up all substances in nature?
5. What does the Greek atomism date back to? Who were its representatives?
6. What discovery gave way to the rise of metallurgy?
7. When did gold become a precious metal?
8. What abilities was the philosopher's stone believed to possess?
9. When did chemistry become a full-fledged science?

Exercise 4. *Provide the terms to the following definitions:*

— A science studied in the Middle Ages, that involved trying to change ordinary metals into gold;
— Uncontrolled flames, light, and heat that destroy and damage things;
— An imaginary substance that was thought in the past to have the power to change any other metal into gold;
— The upper part of the sky;
— A disease that causes death and spreads quickly to a large number people.

Exercise 5. *Find in the text English equivalents to the follow words and word-combinations. Make your own sentences with them.*

Створити основу для різних галузей хімії, протягом століть, бродіння пива та вина, екстракція хімічних речовин із рослин, віддавати тепло і світло, впливати на численні аспекти щоденної життя, первинні (початкові) елементи, неподільна частина матерії, відкриття сплавів, проголошувати, поліпшувати здоров'я людини.

Exercise 6. *Match the beginnings of the sentences with their right endings.*

1. Physical chemistry is the branch of chemistry	a) while researching the glow produced b cathode rays.
2. Much of solid state chemistry deals with the synthesis	b) of the next highest atomic number.
3. Alchemists not only wanted to convert metals to gold	c) providing methods for determining which elements and chemicals are present in the world around us.
4. Enrico Fermi bombarded elements with neutrons and produced	d) but they also wanted to find a chemic concoction that would enable people to li' longer and cure all ailments.
5. Analytical chemistry has been important since the early days of chemistry	e) that applies physics to the study chemistry.
6. Wilhelm Roentgen accidentally discovered x-rays	f) and characterization of new solid state materials.

Exercise 7. *There are several branches of chemistry. Match the branches of chemistry with an overview of what each branch of chemist studies.*

Analytical Chemistry, Organic Chemistry, Environmental Chemistry, Agrochemistry, Geochemistry, Biochemistry, Astrochemistry

a) This branch of chemistry deals with the application of chemistry fi agricultural production, food processing, and environmental remediation because of agriculture;

b) It is the branch of chemistry involved with studying the properties of materials or developing tools to analyze materials;

c) It is the study of the composition and reactions of the chemical elements and molecules found in the stars and in space and of the interactions between this matter and radiation;

d) It is the branch of chemistry concerned with the chemical reactions that occur inside living organisms;

e) It is the chemistry associated with soil, air, and water and of human impact on natural systems;

f) It is the study of chemical composition and chemical processes associated with the Earth and other planets;

g) This branch of chemistry deals with the chemistry of carbon and living

things.

Exercise 8. *Translate into English the words in brackets. Make a short annotation of the text.*

Problems Encountered with Alchemy

There were several problems with alchemy. There was no (єдиної номенклатурної системи) for new compounds, and the language was (езотерична і приблизна) to the point that the terminologies meant (різні речі для різних людей). To a large degree, this language is (незрозумілою) to us today. Soon (найбільш шахрайська сторона) side of alchemy, especially (виготовлення фальшивого золота) gold from cheap substances, was exposed. In 1317 the Avignon Pope John XXII ordered all alchemists to leave France (за виробництво фальшивих грошей). A law was passed in England in 1403, which made the "multiplication of metals" (злочином, що карається смертю). Despite these and other apparently (крайні міри), alchemy did not die. Royalty and privileged classes still sought to (відкрити філософський камінь) and (еліксир життя) for themselves.

Many alchemists included in their methods (несуттєву інформацію) such as the timing of the tides or (фази місяця). The esoteric nature and codified vocabulary of alchemy appeared to be more useful in (приховування того факту) that they could not be sure of very much at all. As early as the 14th century, cracks seemed to grow in the facade of alchemy; and people became skeptical.

Exercise 9. *Translate into English.*

Хімія - це галузь науки, яка існує вже досить довго. Фактично, хімія була заснована до нашої ери. Завдяки такому великому часовому проміжку хімія розділилася на чотири загальні хронологічні категорії: доісторичний період - початок нашої ери (чорна магія); початок нашої ери - кінець 17-го століття (алхімія); кінець 17-го - середина 19-го століття (традиційна хімія); середина 19-го століття - сьогодення (сучасна хімія). Традиційна хімія почалася з руйнування теорії Аристотеля про чотири первинні елементи та переконання що безглуздості ідей про філософський камінь. Вчені перестали вірити можливість перетворення дешевих металів на золото та існування еліксиру молодості, котрий міг вилікувати всі хвороби.

Exercise 10. *Revise your knowledge in chemistry. Match the time periods with the famous discoveries in chemistry. Explain their meaning*

the development of science.

1700 BC	a) Rutherford created an atomic model: the atom contained extremely tiny, dense positively charged nucleus (full protons) surrounded by electrons.
430 BC	b) William Crookes made headway in modem atomic the when he used the vacuum tube made by Heinrich Geissler discover cathode rays.
300 BC	c) Johann J. Beecher believed in a substance call phlogiston. When a substance is burned, phlogiston w supposedly added from the air to the flame of the burning object.
300 BC – 300 AD	d) Aristotle declares the existence of only four elements: air, water and earth.
1700's	e) Known metals were recorded and listed in conjunction heavenly bodies.
1803	f) Democritus proclaims the atom to be the simplest unit matter. All matter was composed of atoms.
1879	g) The Advent of the Alchemists.
1895	h) John Dalton publishes his Atomic Theory, which states all matter is composed of atoms, which are small indivisible.
1911	i) Wilhelm Roentgen accidentally discovered x-rays while researching the glow produced by cathode rays.

Exercise 11. *Find the discovery in the chemical science that consider to be crucial to the further development of chemistry or any of branches and make a short presentation paying attention to the follow points: 1) the year of the discovery; 2) the scientist who did it; 3) the fur development of the science basing on this discovery.*

Exercise 12. *Find the words that go together.*

to form	metals
to extract	heat and light

to make	primary elements
to ferment	one substance into another
to dye	leather
to seek	fat into soap
to tan	cloth
to render	beer and wine
to transform	pottery and glazes
to produce	metals from ores
to identify	the basis of chemistry
to purify	the philosopher's stone

Exercise 13. *Translate the verbs paying attention to their meanings that depend on the preposition and words they go with. Find their synonyms and antonyms.*

to make for	*to give up*	*to turn on*	*to make up*
to make into	*to give back*	*to turn into*	*to give away*
to make out	*to give way*	*to turn down*	*to turn off*

Syn.: to refuse, to return, to reveal, to create, to have success, to depend, to stop, to lead to, to transform, to yield, to convert, to leave.

Ant. : to go backward, to destroy, to fail, to keep, to hide, to continue, to borrow, to lead, to stick to, to remain, to except, to be free from.

Exercise 14. *Translate the sentences using the verbs from Ex. 13.*

1. Сучасна хімічна наука цілком відмовилась від ідей Аристотеля про чотири первинні елементи матерії. 2. Алхіміки щиро вірили в існування філософського каменя, за допомогою якого можна легко перетворити дешеві метали на золото. 3. Віра в існування філософського каменя поступилася місцем атомістичним теоріям. 4. Зрештою алхіміки відмовились від пошуків еліксиру молодості. 5. Вчені-атомісти припускали, що вся природа складається з атомів - неподільних частин. 6. Відкриття закону про збереження маси призвело до становлення сучасної хімії.

Exercise 15. *Read and translate the text. Restore the questions to the following text.*

The Founders of Modern Chemistry

In the Arab World, the Muslims were translating the works of the ancient Greeks and Egyptians into Arabic and were experimenting with scientific ideas. The development of the modem scientific method was

slow and arduous, but an early scientific method for chemistry began emerging among early Muslim chemists, beginning with the 9th century chemist Jabir ibn Hayyan (known as "Geber" in Europe), who is "considered as the father of chemistry". He introduced a systematic and experimental approach to scientific research based in the laboratory, in contrast to the ancient Greek and Egyptian alchemists whose works were largely allegorical and often unintelligible. He also invented and named the alembic, chemically analyze many chemical substances, composed lapidaries, distinguished between alkalis and acids, and manufactured hundreds of drugs. He also refined the theory of five classical elements into the theory of seven alchemical elements after identifying mercury and sulfur as chemical elements.

Robert Boyle, one of the co-founders of modem chemistry through his use of proper experimentation, which further separated chemistry from alchemy. Robert Boyle (1627-1691) is considered to have refined the modem scientific method for alchemy and to have separated chemistry further from alchemy. Robert Boyle was an atomist, but favored the word corpuscle over atoms. He commented that the finest division of matter when the properties were retained was at the level of corpuscles. Boyle was credited with the discovery of Boyle's Law. He was also credited for his publication The Sceptical Chemist, where he attempted to develop an atomic theory of matter, with no small degree of success. He laid the foundations for the Chemical Revolution with his mechanical corpuscular philosophy, which in turn relied on the alchemical corpuscular theory and experimental method.

Despite all these advances, the person celebrated as the "father of modem chemistry" is Antoine Lavoisier who developed his law of conservation of mass in 1789, also called Lavoisier's Law. With this, chemistry acquired a strict quantitative nature, allowing reliable prediction to be made.

Exercise 17. *Retell the history of chemistry, and its well-known discoveries. Tell about the famous chemists with the following word combinations.*

- the first attempts to study chemical character of surrounding nature;
- the first chemical reaction used in a controlled manner;
- atomism of ancient Greeks and Indians;
- the discovery of glass and the metals purification;
- the philosopher's stone;
- clear differentiation between chemistry and alchemy.

Exercise 16. Match the famous women with the discoveries they made in modern chemistry.

Joan Berkowitz **Jacqueline Barton** **Ruth Benerito** **Ruth Erica Benesch** **Carolyn Bertozzi**	1. She has helped to design artificial bones that are less likely to cause reactions or lead to rejection than their predecessors. She has helped create contact lenses that are better-tolerated by the cornea of the eye. 2. She and her husband made a discovery that helped explain how hemoglobin releases oxygen in the body They learned that carbon dioxide functions as an indicator molecule, causing hemoglobin to release oxygen where carbon dioxide concentrations are high. 3. She invented wash-and-wear cotton fabric. Chemic; treatment of the cotton surface not only reduced wrinkles, but could be used to make it flame resistant and stain 4. She probed DNA with electrons. She used custom-made molecules to locate genes and study their arrangement. She has shown that some damaged DNA molecules do not conduct electricity. 5. She used her command of chemistry to help solve problems with pollution and industrial waste.

UNIT 4
THE ATOMIC THEORY

Exercise 1. *Learn the following words and word combinations:*

discrete unit - абстрактна одиниця
arbitrarily tiny quantities - умовно крихітні кількості
to vary considerably - суттєво коливатися, варіюватися
spiritual element - духовний елемент
to date back to - датуватися
to coin the term - створювати термін
uncuttable - неподільний
theory of light - теорія світла
single, unique type - окремий унікальний вид
modem atomic theory - сучасна атомна теорія
additional line of reasoning - додатковий аргумент для обґрунтування
dust grains floating in water - крупинки пилу, що плавають у воді
to move about erratically - дивно рухатися
Brownian motion - броунівський рух
to have a positive charge - мати позитивний заряд
raisins - родзинки
surface of a lump of pudding - поверхня шматка пудингу
to bombard with alpha rays - опромінювати альфа променями
solar system - сонячна система
to identify building blocks - визначати складові компоненти
nuclei of all elements - ядра всіх елементів
to orbit at certain distances - кружляти по орбіті на певній відстані
to radiate energy - випромінювати енергію
to absorb energy - поглинати енергію
to boost – піднімати

Exercise 2. *Read and translate the text. Draw the pictures to describe Thomson's, Rutherford's, and Bohr's atomic models.*

Atomism

The concept that matter is composed of discrete units and cannot be divided into arbitrarily tiny quantities has been around for millennia. The nature of atoms in philosophy varied considerably over time and between cultures and schools, and often had spiritual elements. References to the concept of atoms date back to ancient Greece and India. In approximately 450 BC, Democritus coined the term *atomos,* which means "uncuttable" or "the smallest indivisible particle of matter".

In 1661, natural philosopher Robert Boyle argued that matter was composed of various combinations of different atoms, rather than the classical elements of air, earth, fire and water. During the 1670s the same idea was used by Isaac Newton in his development of the theory of light.

In 1805, English instructor and natural philosopher John Dalton proposed that each element consists of atoms of a single, unique type, and that these atoms can join together to form chemical compounds. Dalton is considered the originator of modern atomic theory.

An additional line of reasoning in support of particle theory began in 1827 when botanist Robert Brown used a microscope to look at dust grains floating in water and discovered that they moved about erratically - a phenomenon that became known as "Brownian motion".

In 1897, English physicist J.J. Thomson discovered the electron and proposed a model for the structure of the atom. Thomson knew that electrons had a negative charge and thought that matter must have a positive charge. His model looked like raisins stuck on the surface of a lump of pudding.

In the beginning of the 20^{th} century Ernest Rutherford bombarded atoms with alpha rays to investigate the inside of the atom. The results of the experiments came unexpected. Rutherford thought that the negative electrons orbited a positive center in a manner like the solar system where the planets orbit the sun. Rutherford finally identified the particles of the nucleus as discrete positive charges of matter. He named them protons, from the Greek for 'first', for they consisted of the first identified building blocks of the nuclei of all elements. But there appeared something wrong with Rutherford's model of the atom.

In 1912 a Danish physicist, Niels Bohr came up with a theory that contained the rules for what happened in atom:

1) Electrons can orbit only at certain allowed distances from the nucleus;
2) Atoms radiate energy when an electron jumps from a higher-energy orbit to a lower-energy orbit.
3) Atom absorbs energy when an electron gets boosted from a low-energy orbit to a high-energy orbit;
4) Light (photons) emit whenever an electron jumps from one orbit to another.

By the 1920s, further experiments showed that Bohr's model of the atom had some troubles. Bohr's atom seemed too simple to describe the heavier elements. In fact it only worked roughly in these cases. The spectral lines did not appear correct when a strong magnetic field influenced the atoms.

Exercise 3. *Answer the following questions to the text.*

1. When did the discrete units of matter concept appear? 2. In what countries did the scientists first suggest the concept of an atom? 3. Who coined the term "atom"? 4. What does this term mean? 5. When did natural philosopher Robert Boyle argue the composition of matter theory? 6. What did English instructor and natural philosopher John Dalton propose in 1805? 7. What phenomenon is known as "Brownian motion"? 8. What did English physicist J.J. Thomson discover? 9. What does Ernest Rutherford's atomic model look like? 10. What rules are in Bohr's theory of the atom?

Exercise 4. *Identify one underlined word that must be changed to make the sentence correct.*

1. The character of atoms in philosophy varied considerably over time. 2. References to the concept of element date back to ancient Greece and India. 3. In approximately 450 BC, Democritus coined the notion atomos. which means "uncuttable". 4. English instructor and natural philosopher John Dalton proposed that each element consists of atoms of a same type. 5. Dalton's model looked like raisins stuck on the surface of a lump of pudding. 6. In the beginning of the 19th century Ernest Rutherford bombarded atoms with alpha rays to investigate the inside of the atom.

Exercise 5. *Match the discoveries with the appropriate country.*

Greece	1) energy orbit theory;
England	2) discovery of the electron and the model for the structure of the atom;
India	3) discovery of protons;
England	4) a phenomenon known as "Brownian motion";
Denmark	5) the theory of light;
Ireland	6) origin of modem atomic theory;
England	7) theory about composition of matter as various combinations of different atoms, rather than the classical elements of air, earth, fire and water;
Scotland	
New Zealand	8) concept that matter is composed of discrete units;
	9) term atomos, which means "uncuttable".

Exercise 6. *Restore the questions to the following statements.*

1. In about 600 B.C. Thales of Miletus discovered that a piece amber, after rubbing it with fur, attracts bits of hair and feathers and other light objects. 2. Aristotle dismissed the atomic idea of Democritus

worthless. 3. Rutherford used Radium as the source of the alpha particle and shinned them onto the atoms in gold foil. 4. Rutherford thought that the negative electrons orbited a positive center in a manner like the solar system where the planets orbit the sun. 5. Atom absorbs energy when an electric gets boosted from a low-energy orbit to a high-energy orbit.

Exercise 7. *Open the brackets and write the correct form of the verb.*

Atom and its structure

The atom (to be) a basic unit of matter that (to consist) of a dense central nucleus surrounded by a cloud of negatively charged electrons. The atomic nucleus (to contain) a mix of positively charged protons an electrically neutral neutrons (except in the case of hydrogen). The electron of an atom (to bound) to the nucleus by the electromagnetic force.

The name atom (to come) from the Greek atomos, which (to mean) uncuttable, or indivisible, something that cannot (to divide) further. The concept of an atom as an indivisible component of matter first (to propose) by early Indian and Greek philosophers. In the 17th and 18th centuries, chemists (to provide) a physical basis for this idea by showing that certain substances (can, not, to break down) further by chemical methods. During the late 19th and early 20th centuries, physicists (to discover) subatomic components and structure inside the atom, thereby demonstrating that the 'atom' (to be) divisible.

Exercise 8. *Make up the sentences of your own with the given word combinations.*

The concept of matter, the concept of atoms, the smallest indivisible particle of matter, to form chemical compounds, to look at dust grains floating in water, to investigate the inside of the atom, to radiate energy, to absorb energy, a dense central nucleus, a cloud of negatively charged electrons.

Exercise 9. *Match the beginnings of the sentences with their right* endings.

1. Electrons are 2. Electrons are extremely small 3. The mass of an electron is 4. Because electrons move so quickly, 5. Neutrons play a major role in 6. Neutrons are 7. Electrons are found in 8. All of the electrons of an atom	a) the mass and radioactive properties of atoms. b) the particles on an atom that have a neutral charge. c) it is impossible to see where they are at a specific moment in time. d) clouds that surround the nucleus of an atom. e) almost 1,000 times smaller than the mass of a proton. f) compared to all of the other parts of the atom. g) create a negative charge. h) the negatively charged particles of atoms.

Exercise 10. *Read and translate the text paying special attention to the role of the infinitive in the sentence.*

Atoms around Us

To have a language an alphabet is needed. *To build proteins* amino acids come in hand. Other examples in chemistry are not any different. *To build molecules* elements are required. Each element is a little bit different from the rest. Those elements are the alphabet to the language of molecules.

To stretch the idea a bit, reading a book means reading a language. Letters make up that language. But ink makes those letters possible. Ink is needed *to crate the letters.* And for each letter, it is the same type of ink.

Transforming this into chemical terms, elements are like those letters. They have something in common. That is where atoms come in. All elements are made of atoms. While the atoms may have different weights and organization, they are all built in the same way. Electrons, protons, and neutrons make the universe go.

To broaden the idea, matter, the stuff around us, is used *to create atoms.* Atoms are used *to create the elements.* Elements are used *to create molecules.* It just goes on. Everything is built by using something else.

Exercise 11. *Translate the sentences into English using Infinitive construction.*

1. Важливо знати, з чого складається світ, що нас оточує. 2.

Щоб краще пояснити роль молекул, елементів та атомів, слід порівняти їх зі вживанням мови, алфавіту та чорнила. 3. Р. Браун скористався мікроскопом для дослідження хаотичного руху пилу у воді, що пізніше стало відомим як броунівський рух. 4. Вченим легко уявити будову кожного атома, оскільки атоми різної ваги мають однакову структуру. 5. За теорією Бора, щоб атом вивільнив енергію електрону потрібно перейти з вищої орбіти на нижчу. 6. Для побудови молекули потрібні елементи.

Exercise 12. *Put the given notions in the order, starting with the smallest.*

Biospheres	Macromolecules
Atoms	Planetary Systems with Stars
Tissues	Cell organelles
Organisms	Systems
Ecosystems	Organs
Elements	Planets
Molecules	Galaxies
Populations	The Universe

Exercise 13. *Provide the terms to the following definitions.*

- A unit of matter, the smallest unit of an element, consisting of a dense, central, positively charged nucleus surrounded by a system of electrons;
- The central part of an atom, made up of neutrons, protons and other elementary particles;
- A very small piece of matter with a positive electrical charge;
- A part of an atom that has no electrical charge;
- A very small piece of matter with a negative electrical charge.

Exercise 14. *Work in pairs and act out a dialogue concerning the concept of atom between:*

a) Democritus and Niels Bohr;
b) Robert Boyle and Ernest Rutherford;
c) Isaac Newton and J.J. Thomson;
d) John Dalton and Robert Brown.

Exercise 15. *A) Read the text, and put ten questions to the text.*

Main Types of Bonds in Atoms

There are two main types of bonds that hold atoms together, covalent and electrovalent/ionic bonds. Covalent compounds happen when

the atoms share the electrons, and ionic compounds happen when electrons are donated from one atom to another.

Bonds are built and broken down by chemical forces. Physical forces usually cannot break down compounds. Chemical forces are forces caused by other compounds or molecules that act on substances.

There are millions of different compounds. When elements join and become compounds, they lose their individual traits. Sodium alone is very reactive. But when sodium and chlorine combine, they form a non-reactive substance called sodium chloride (Salt, NaCl). The compound has none of the traits of the original elements. The new compound is not as reactive as the original elements. It has a new life of its own.

Most compounds are made up of combinations of bonds. Sodium chloride (NaCl) is held together by one ionic bond. In magnesium chloride ($MgCl_2$) there are one magnesium (Mg) and two chlorine (Cl) atoms. There are two ionic bonds. There's a compound called methane (CH_4). It is made up of one carbon (C) and four hydrogens (H). There are four bonds and they are all covalent. Those examples are very simple compounds, but most compounds are combinations of ionic and covalent bonds.

In sodium hydroxide (Na-OH) on the left is the sodium (Na) part and the right has the oxygen/hydrogen (-OH) part. The bond that binds the hydrogen (H) to the oxygen (O) is covalent. The sodium (Na) is bonded to the hydroxide part of the compound with an ionic bond. This is a very good example of how there can be different types of bonds within one compound.

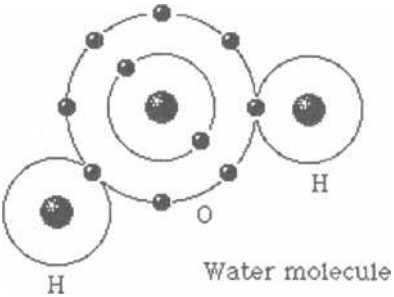
B) Give the example of other compounds with different types of bonds in their atoms. Illustrate your answer.

Exercise 16. *State, which of these statements are true from the point of chemistry?*

1. Atoms are minuscule objects with proportionately tiny masse 2. Atoms can only be observed individually using special instruments such as the scanning tunneling microscope. 3. Over 99.9% of an atom's mass is concentrated in the nucleus, with protons and neutrons having roughly equal mass. 4. Electrons that are bound to atoms possess a set of stable energy levels, or orbitals, and can undergo transitions between them by absorbing or emitting photons that match the energy differences between the level. 5. The electrons determine the chemical properties of an element, and strongly influence an atom's magnetic properties.

Exercise 17. *Describe the molecule below. State its properties*

judging by the structure.



Exercise 18. *Read about a very special element and guess what this element is.*

One Special Element

All elements have atoms with neutrons except for one. Its normal atom does not have any neutrons in its tiny nucleus. That tiny little atom (the tiniest of all) has only one electron and one proton. You can take away the electron and make an ion, but you can't take away any neutrons. That special structure becomes very important when you learn how this element interact with other elements in the periodic table.

Exercise 19. *Insert the missing words and word combinations in the text.*

negatively, flow, negative charge, move, positive charge, jump, nucleus, electrons, mass, currents of electricity, proton, stream, clouds, electronics, nucleus, specific moment

Electrons are the _____ charged particles of atoms. Together, all of the electrons of an atom create a _____that balances the _____ of the protons in the atomic _____. Electrons are extremely small compared to all of the other parts of the atom. The _____ of an electron is almost 1,000 times smaller than the mass of a _____. Electrons are found in _____ _____that surround the _____ of an atom. Because electrons move so quickly, it is impossible to see where they are at a _____in time.

Electrons are very important in the world of _____. The very small particles _____through wires and circuits creating _____. The electrons move from negatively charged parts to positively charged ones. The negatively charged pieces of any circuit have

extra _____while the positively charged pieces want more electrons. The electrons then _____ from one area to another. When the electrons _____, the current can _____ _____through the system.

Exercise 20. *Tell about different concepts of atom, well-known scientists who contributed to the modern atomic theory, and about an atom and its structure, using the information from the texts in Exercises 2 and 7.*

Exercise 21. *Write a short article about the significant role of the discovery of an atom in the development of the science.*

UNIT 5
HISTORY OF THE PERIODIC TABLE

Exercise 1. *Learn the following words and word combinations:*

to establish the atomic theory of matter - започаткувати атомістичну теорію матерії
relative weights of atoms - відносна вага атомів
to be periodic function - бути в періодичній залежності
previous attempt - попередня спроба
vacant place - вакантне місце
decade - десятиліття
great breakthrough - великий прорив (відкриття)
respectively - відповідно
to be arranged according to atomic weight - бути розміщеним відповідно до атомної маси
gaps for elements - вільні місця для елементів
to undergo - зазнавати
principal elaboration - принципове вдосконалення
to extend the law - розширювати закон
to suspect - підозрювати
to comprise - охоплювати
in terms of the theory - з точки зору
key to thé success - ключ до успіху
effort - зусилля
realization - усвідомлення
improved version of the periodic table - удосконалена версія періодичної таблиці

Exercise 2. *Read and translate the text.*

History of the Periodic Table

As a result of discoveries that firmly established the atomic theory of matter in the first quarter of the 19th century, scientists could determine the relative weights of atoms of the known elements. The chemical law that the properties of all the elements are periodic functions of their atomic weights was developed independently by two chemists, in 1869 by the Russian Dmitry Mendeleev and in 1870 by the German Julius Lothar Meyer. The key to the success of their efforts was the realization that previous attempts had failed because a number of elements were as yet undiscovered and that vacant places must be left for such elements in the classification.

For many decades, the list of known chemical elements had been steadily increasing. A great breakthrough in making sense of this long list was Dmitry Mendeleev's development of the periodic table, and particularly Mendeleev's use of it to predict the existence and the properties of germanium, gallium, and scandium, which he called ekasilicon, ekaaluminium, and ekaboron respectively. Mendeleev made his prediction in 1870. This table displays a periodicity in the elements' properties when they are arranged according to atomic weight.

Working as a Professor of General Chemistry at the University of St Petersburg and writing two-volume Principles of Chemistry Mendeleev tried to classify the elements according to their chemical properties. In 1869 he published his first version of what became known as the periodic table. In 1871 he published an improved version of the periodic table, in which he left gaps for elements that were not yet known.

The periodic law has undergone two principal elaborations since its original formulation by Mendeleev and Meyer. The first revision involved extending the law to include a whole new family of elements, the existence of which was completely unsuspected in the 19th century. This group comprised the first three of the noble, or inert, gases argon, helium, and neon, discovered in the atmosphere between 1894 and 1898 by the British physicist John William Strutt, and the British chemist Sir William Ramsay. The second development in the periodic law was the interpretation of the cause of the periodicity of the elements in terms of the Bohr Theory (1913) of the electronic structure of the atom.

Exercise 3. *Answer the following questions.*

1. Why could scientists determine the relative weights of atoms of the known elements? 2. What does the periodic law state? 3. Who and when developed the periodic law? 4. Why had the previous attempts to classify the known elements failed? 5. Who made a great breakthrough in making sense of the long list of elements? 6. What did Mendeleev predict? 7. What elements were first called ekasilicon, ekaaluminium, and ekaboron? 8. What does the periodic table display? 9. Due to what events did the periodic table undergo two principal elaborations?

Exercise 4. *Say whether the given sentences are true or false.*

1. The chemical law states the properties of all the elements are periodic functions of their atomic weights. 2. The periodic table was developed only in 1869 by the Russian Dmitry Mendeleev. 3. For many decades, the list of known chemical elements had been steadily decreasing.

4. Mendeleev used the periodic table to predict the existence and the properties of germanium, gallium, and sodium. 5. Mendeleev tried to classify the elements according to their chemical properties. 6. The first development in the periodic law was the interpretation of the cause of the periodicity of the elements in terms of the Bohr Theory.

Exercise 5. *Match the terms with their definitions. Memorize them.*

Period	Elements in a horizontal row of the periodic table.
Periodicity	When the elements are arranged by atomic number, their physical and chemical properties vary periodically. The properties of the elements are periodic functions of their atomic numbers.
Periodic law	An arrangement of elements in an order of increasing atomic numbers that also emphasizes periodicity.
Periodic table of elements	With increasing atomic number, the electron configuration of the atoms displays a periodic variation.

Exercise 6. *Fill the chart with the missing words.*

Verb	**Noun**	**Adjective**	**Adverb**
to determine			
			independently
	success		
		increasing	
to publish			
	elaboration		

Exercise 7. *Find the words that go together.*

to establish	to display
to determine	to arrange
to leave	to classify
to increase	to undergo
to make	to extend
to predict	

The law, principal elaboration, the elements, according to atomic weight, the existence of elements, periodicity, list of known chemical elements, sense, vacant place, the relative weight of atom, the atomic theory.

Exercise 8. *Match the beginnings of the sentences with their ending*

1) The horizontal form familiar to us soon replaced 2) Radiation, first discovered in 1898 by Henri Becquerel, was 3) The blank spaces in Mendeleev's original vertical periodic table were 4) The era of nuclear chemistry began 5) All of the new elements predicted by Moseley 6) The "rare earth" elements are today recognized to include 7) The 8th element after lithium is 8) In 1869, Mendeleev ordered the 63 then-known elements	a) according to increasing atomic mass. b) the original vertical periodic table. c) sodium, and eight elements later come potassium. d) a by-product of naturally occurring transmutations of elements exchanging identities. e) lanthanum, as well as the lighter elements yttrium and scandium. f) predictions of new elements such gallium and germanium. g) were found within the next 24 years. h) in earnest in the late 1930s.

Exercise 9. *Translate the text into English; add additional information about Dmitry Mendeleev with is not reflected in the text.*

Дмитро Менделєєв народився у Сибіру, був останнім з чотирнадцяти дітей. Після смерті батька сім'я переїздить до Петербургу, де у кінці 1860-х років Д. Менделєєв почав працювати над своїм найбільшим досягненням - періодичною таблицею елементів. Розмістивши 63 відомі на той час елементи за їхньою атомною вагою, вченому вдалося згрупувати їх за подібними властивостями. Менделєєв передбачив існування нових елементів у тих місцях таблиці, де були порожні клітини. Цими елементами виявилися галій, скандій та германій. Саме це забезпечило беззаперечне визнання його періодичної таблиці, як наріжного каменя науки хімії і нашого розуміння всесвіту. Вчений змінив наше розуміння властивостей атомів і створив таблицю, яка побувала у шкільних класах хімії всього світу.

Exercise 10. *Retell the text History of the Periodic Table paying attention to the following key points:*

- The discoveries that firmly established the atomic theory;

- The chemical law of periodicity;
- The key to the success of Mendeleev's and Meyer's efforts;
- A great breakthrough in making sense of the elements list;
- Two principal elaborations of periodic law.

Exercise 11. *Work in pairs and make the list of everything you know about chemical element as a substance. Pay special attention to the following points:*

a) its structure;
b) its place in periodic table;
c) element's atomic number;
d) all elements' arrangement in the periodic table.

Chemical Element

The concept of chemical element is related to chemical substance. A chemical element is specifically a substance which is composed of a single type of atom. A chemical element is characterized by a particular number of protons in the nuclei of its atoms. This number is known as the atomic number 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. Ninety four different chemical elements or types of atoms based on the number of protons exist naturally. A further 18 have been recognised by IUPAC (the International Union of Pure and Applied Chemistry) as existing artificially only. Although all the nuclei of all atoms belonging to one element will have the same number of protons, they may not necessarily have the same number of neutrons; such atoms are termed isotopes. The most convenient presentation of the chemical elements is in the periodic table of the chemical elements, which groups elements by atomic number. Due to its ingenious arrangement, groups, or columns, and periods, or rows, of elements in the table either share several chemical! properties, or follow a certain trend in characteristics such as atomic radius» electronegativity, etc.

Exercise 12. *Read the names of the chemical elements, find their transcriptions, and memorize the spelling of each element.*

Nomenclature of substances is a critical part in the language of chemistry. Generally it refers to a system for naming chemical compounds, j Earlier in the history of chemistry substances were given names by the[1] discoverers, that often led to some confusion and difficulty. However,

today the IUPAC system of chemical nomenclature allows chemists to specify by name specific compounds amongst the vast variety of possible chemicals. The standard nomenclature of chemical substances is set by the International Union of Pure and Applied Chemistry (IUPAC).

1. H - Hydrogen
2. He - Helium
3. Li - Lithium
4. Be - Beryllium
5. B - Boron
6. C - Carbon
7. N - Nitrogen
8. O - Oxygen
9. F - Fluorine
10. Ne - Neon
11. Na - Sodium
12. Mg - Magnesium
13. A1 - Aluminium
14. Si - Silicon
15. P - Phosphorus
16. S - Sulfur
17. Cl - Chlorine
18. Ar – Argon
19. K – Potassium
20. Ca – Calcium
21. Sc – Scandium
22. Ti – Titanium
23. V – Vanadium
24. Cr – Chromium
25. Mn – Manganese
26. Fe – Iron
27. Co – Cobalt
28. Ni – Nickel
29. Cu – Copper
30. Zn – Zinc
31. Ga – Gallium
32. Ge – Germanium
33. As –Arsenic
34. Se – Selenium
35. Br – Bromine
36. Kr - Krypton
61. Pm – Promethium
62. Sm – Samarium
63. Eu – Europium
64. Gd – Gadolinium
65. Tb – Terbium
66. Dy – Dysprosium
67. Ho – Holmium
68. Er – Erbium
69. Tm – Thulium
70. Yb – Ytterbium
71. Lu – Lutetium
72. Hf – Hafnium
73. Ta – Tantalum
74. W – Tungsten
75. Re – Rhenium
76. Os – Osmium
77. Ir – Iridium
78. Pt – Platinum
79. Au – Gold
80. Hg – Mercury
81. Tl – Thallium
82. Pb – Lead
83. Bi – Bismuth
84. Po – Polonium
85. At – Astatine
86. Rn – Radon
87. Fr – Francium
88. Ra – Radium
89. Ac – Actinium
90. Th – Thorium
91. Pa – Protactinium
92. U – Uranium
93. Np – Neptunium
94. Pu – Plutonium
95. Am – Americium
96. Cm – Curium

37. Rb – Rubidium
38. Sr – Strontium
39. Y – Yttrium
40 Zr – Zirconium
41. Nb – Niobium
42. Mo – Molybdenum
43. Tc – Technetium
44. Ru –Ruthenium
45. Rh – Rhodium
46. Pd – Palladium
47. Ag – Silver
48. Cd – Cadmium
49. In – Indium
50. Sn – Tin
51. Sb – Antimony
52. Te – Tellurium
53. 1 – Iodine
54. Xe – Xenon
55. Cs – Cesium
56. Ba – Barium
57. La – Lanthanum
58. Ce – Cerium
59. Pr – Praseodymium
60. Nd – Neodymium
97. Bk – Berkelium
98. Cf – Californium
99. Es – Einsteinium
100. Fm – Fermium
101. Md – Mendelevium
102. No – Nobélium
103. Lr – Lawrencium
104. Rf – Rutherfordium
105. Db – Dubnium
106. Sg – Seaborgium
107. Bh – Bohrium
108. Hs – Hassium
109. Mt – Meitnerium
110. Ds – Darmstadtium
111. Rg – Roentgenium
112. Cn – Copemicium
113. Uut – Ununtrium
114. Uuq – Ununquadium
115. Uup – Unnpentium
116. Uuh – Ununhexium
117. Uus - Ununseptium
118. Uuo - Ununoctium

Exercise 13. *Reade the following elements*.
Si, P, Ar, K, Sc, Ti, Mn, Fe, Ni, N, O, F, Ne, Cu, Ge, As, Se, B.

Exercise 14. *Match the elements with their names.*

Am	Cr	La	P
Sb	Ga	W	Os
Cd	Au	Ta	N
B	He	Na	Ni
At	H	Ag	Hg
C	I	Si	Md
Es	Fe	Po	Pb

Hydrogen, iodine, iron, lanthanum, lead, carbon, chromium, einsteinium, gallium, gold, helium, phosphorus, polonium, mendelevium,

mercury, nickel, nitrogen, osmium, americium, antimony, astatine, boron, cadmium, silicon, silver, sodium, tantalum, tungsten.

Exercise 15. *Write the chemical symbols of the following elements.*

Hydrogen, Scandium, Nickel, Manganese, Arsenic, Zinc, Iron Lithium, Vanadium, Sulfur, Chlorine, Argon, Aluminum, Silicon, Carbon, Nitrogen, Fluorine.

Exercise 16. *Translate the sentences into English.*

1. Перші хіміки намагалися розмістити елементи з точки зору зручності та практичного використання. 2. Спочатку хіміки розділили елементи на метали та неметали. 3. Коли кількість відомих елементів зростала, і вчені більше дізнавалися про них, їх спантеличення тільки збільшувалося. 4. Час від часу пропонувалися все нові і нові способи класифікувати елементи. 5. Перші системи класифікації елементів були грубими та базувалися на атомних масах.

Exercise 17. *Match the word combinations to make the comparisons. Find the Ukrainian equivalents and explain which of them have chemical background and why. Use them in the sentences of your own.*

As brave as	a lead
As fat as	a lion
As heavy as	iron
As hard as	a pancake
As flat as	a new pin
As dry as	a pig
As clean as	a coal
As bright as	a bee
As black as	a button
As hairy as	a bone
As clear as	a gorilla
As busy as	crystal

Exercise 18. *Work in pairs and act out a dialogue between:*

a) *Dmitry Mendeleev and Julius Lothar Meyer;*
b) *Hydrogen and Nitrogen (a funny one);*
c) *Dmitry Mendeleev and a student of the University of Ukraine*

UNIT 6
THE PERIODIC TABLE

Exercise 1. *Learn the following words and word combinations:*
to recur in a systematic manner - систематично повторюватися
to approximate - наближатися, приблизно дорівнювати
precursor - попередник, провісник
at regular intervals — через регулярні проміжки
a tabular display - табличний вираз, зображення
rectangular in general outline - прямокутний за формою
horizontal row - горизонтальний ряд
vertical column - вертикальна колонка
alkali metals - лужні метали
alkali earths - лужно-земельні метали
noble gases - благородні гази
halogens - галогени
application - застосування
diverse fields — різноманітні
галузі boiling and melons pones - точки кипіння та танення
outside electron shell - зовнішня електронна оболонка
conductor of beat – теплопровідик
dull appearance - тьмяний вигляд
brittle - крихкий
to tend - прагнути
semi-metals – напівметали

Exercise 2. *Read and translate the text.*

The Periodic Table

Periodic Law states that many of the physical and chemical properties of the elements tend to recur in a systematic manner with increasing atomic number. Progressing from the lightest to the heaviest atoms, certain properties of the elements approximate those of precursors at regular intervals of 2, 8, 18 and 32. For example, the 2nd element (helium) is similar in its chemical behavior to the 10th (neon), as well as to the 18th (argon), the 36th (krypton), 54th (xenon), and the 86th (radon).

The periodic tabic of chermical elements is a tabular display of the 118 known chemical elements organized by selected properties of their atomic structures. Elements are presented by increasing atomic number, the number of protons in an atom's atomic nucleus. While rectangular in general outline, gaps are included in the horizontal rows (known as

periods) as needed to keep elements with similar properties together in vertical columns (known as groups), e.g. alkali metals, alkali earths, halogens, noble gases.

Since the periodic table accurately predicts the abilities of various elements to combine into chemical compounds, it has found many applications not only in chemistry and physics, but also in such diverse fields as geology, biology, materials science, engineering, agriculture, medicine, nutrition, environmental health, and astronomy. Its principles are especially important in chemical engineering.

There is the group of noble gases, or inert gases, in periodic table that have the following properties: a) for the most part, they do not make chemical combinations with any elements; b) there are certainly no natural compounds with this group; c) they are all gases at room temperature, have very low boiling and melting points.

Metals make the largest category of elements on the Periodic Chart. Metal elements usually have the following properties: a) they have one, two, or three electrons on the outside electron shell; b) metals are good conductors of electricity; c) they have high melting and boiling points, almost all metals are solids at room temperature; d) metals are usually good conductors of heat; e) active metals react with acids, some very active metals react with water.

The properties of non-metals are not as universal to them as the metals. Non-metals have the following properties: a) non-metals usually have four, five, six, or seven electrons in the outer shell; b) elemental non-metals often have a dull appearance; they are more likely to be brittle, or shatter when struck; c) although not a constant rule, non- metals tend to have lower melting and boiling points than metals and the solids tend to be less dense; d) non-metals are not usually good conductors of heat or electricity; e) many non-metals form diatomic or polyatomic molecules with other atoms of the same element.

There isn’t a sharp dividing line between the metals and non-metals. The staircase-shaped line between metals and non-metals has several elements that have properties somewhere between the two categories. Having three electrons in the outside shell, boron is not a metal element. Aluminum is definitely a metal in most of its traits, but it reacts with both acids and bases. Silicon, germanium, arsenic, antimony, and tellurium are on the line between metals and non-metals and exhibit some of the qualities of both. These elements do not really comprise a clear-cut category, but, due to the mix of properties they show, they are often called semi-metals.

Hydrogen is not included in any of the categories. Hydrogen just does not match anything else. More than ninety-nine-point-nine percent of hydrogen is just one proton and one electron.

Exercise 3. *Answer the following question.*

1. What does the Periodic Law state? 2. At what intervals do certain properties of the elements approximate the properties of their precursors? 3. What is the periodic table of the chemical elements? 4. How are elements presented in the periodic table? 5. What fields has the periodic table found many applications? 6. What properties does the group of noble gases have? 7. What is the largest category of elements on the Periodic Chart? 8. What properties do metal elements usually have? 9. What elements form diatomic or polyatomic molecules with other atoms of the same elements? 10. What element is not included in any of the categories?

Exercise 4. *Put all types of questions to the given sentences.*

1. Losing electrons the metal makes positive ions. 2. The ions of metals are usually plus one, plus two, or plus three in charge. 3. The smooth surface of the metal reflects electromagnetic waves in an organized manner. 4. At one time US half dollar coins were made of ninety percent silver. 5. Non-metals can share electrons in a covalent bond or gain electrons to become a negative ion.

Exercise 5. Find the translations in collumn B to the word combinations in column A. Make your own sentences with these phrases.

1) physical and chemical properties	a) чітка розмежувальна лінія
2) to progress from the lightest to the heaviest	b) фізичні та хімічні властивості
3) to select properties	c) реагувати як і з кислотами, так і з солями
4) the abilities of various elements	d) утворювати хімічні сполуки
5) applications in chemistry and physics	e) просуватися від найлегшого до найважчого
6) to make chemical combinations	f) обирати властивості
7) to have high melting and boiling points	g) утворювати двоатомні та поліатомні молекули
8) to react with diatomic or polyatomic molecules	h) реагувати з кислотами та водою
9) to form diatomic or polyatomic molecules	i) властивості різних елементів
	j) застосування в хімії та фізиці
	k) мати високу точку танення та кипіння

10) a sharp dividing line 11) to reacts with both acids and bases	

Exercise 6. *Insert the right prepositions in the gaps.*

in, in, with, from, within, to, to, in, to, from

1: Elements in a vertical column tend _____have similar properties. 2. Progressing _____the left _____ the right elements in a horizontal row show a decrease in metallic properties. 3. All of the halogen elements are almost similar _____ their chemical behavior _____each other: they are poisonous and corrosive. 4. Mendeleev's table was constructed _____ seven elements _____ each of the first two rows and seventeen _____ each of the next two rows. 5. The atoms of oxygen differ _____the atoms of every other element. 6. As the atomic number _____ a family increases, the ionization energy decreases.

Exercise 7. *Match the elements with the scientists who discovered*

Phosphorus	1950 University of California at Berkeley researchers Glenn Seaborg, Albert Ghiorso, Kenneth Street, Jr., and Stanley G. Thompson
Platinum	1898 French physicists Marie and Pierre Curie
Hydrogen	1808 English chemist Sir Humphry Davy
Nitrogen	1774 English chemist Joseph Priestley and Swedish chemist
Oxygen	Carl Wilhelm Scheele
Barium	1772 Scottish physician and chemist Daniel Rutherford
Polonium	1766 English chemist and physicist Henry Cavendish
Californium	1748 Spanish military Leader Don Antonio de Ulloa
	1669 German physician Hennig Brand

Exercise 8. *Translate the text into English.*

Насправді, не було відкрито елементу, який вважався б першим в історії людства. Первісним людям були відомі дев'ять елементів. Це золото, срібло, мідь, залізо, свинець, олово, ртуть, сірка та вуглець. Це елементи, які існують у чистому стані або можуть бути очищені, з використанням відносно простих засобів. Така мала кількість елементів пояснюється тим, що більшість із них зв'язані в сполуки або існують у сумішах з іншими елементами. Наприклад, ми дихаємо киснем кожного дня, але сам елемент у чистому стані

побачити не можемо.

Exercise 9. *Match the element and its description.*

SODIUM CARBON OXYGEN LITHIUM HYDROGEN	1. 1. It is the 1st element in the periodic table and the most basic of all elements in the universe. Over 90% of all the atoms in the universe are its atoms and they are the lightest of all elements. Its name comes from the Latin word which means water. 2. It is the third element of the periodic table and was discovered in 1817 by a chemist Arfvedson. This is the first metal encountered in the periodic table and it is a silvery colored solid when purified. One thing to remember is that it is never found alone in nature. It is always bonded to other elements. 3. People need it to survive? as do all other living organisms. It makes 20% of the Earth's atmosphere. It is very reactive. It is the 8^{th} element of the periodic table and found in the 2^{nd} row. Alone, it is a colorless and odorless compound that is a gas at room temperature. A chemist Priestly isolated it in 1774. 4. This is the magic element for everything on it. It is in nearly every biological compound that makes up our bodies. Located between B and N, it is a very stable element. It can be found in many naturally occuring compounds by itself. Its three states are diamond, amorphous, and graphite. It was never really discovered. Ancient people knew of the black soot left over after a fire. 5. Being in the 1^{st} column of the 3^{rd} period, it is a member of the alkali metal family with K and Li. Its big claim to fame is as one two elements in your table salt. Even though humans have been using it for thousands of years, it was not isolated until 1807 by Davy. It is one of the few metals that will float when it is placed in water. Its atomic mass is less that water's atomic mass.

Exercise 10. *Insert the missing words and word combinations into the text Sulfur.*

in the periodic table, brimstone, available, volcanoes, temperatures, bad smell, bright yellow, crystal, non-reactive, hot springs, bible, on the ground

Sulfur

Sulfur is one of those elements you can never forget. It is _____in color and it has a really _____ (like rotten eggs). Beyond the obvious physical traits of sulfur, man has been using this element for thousands years, because sulfur is often found near _____ and _____. When men found pure elements that were readily _____, they put them to use. Sulfur is even mentioned in the _____ where it is called _____.

It is important to know that something sulfur is also spelled "Sulphur" (English and Australia).

Sulfur is an element that is easy to find _____ and even easier to find _____. It's just under oxygen at position sixteen. Naturally occuring sulfur is a yellowish color and often found as a _____. At normal _____, sulfur is _____.

Exercise 11. *Decide what statements belong to what element.*

IRON, COPPER, NITROGEN, PHOSPHORUS

1) It is a key element in the creation of bronze;
2) It is another one of those elements that can never be found free in nature;
3) This transition metal is well known for the two colors that are reddish when pure and a turquoise when oxidized;
4) When isolated and pure, it is clear and almost transparent;
5) There is a whole period of time named after this element;
6) There are four common forms used today: white, black, red, and violet;
7) It is a clear gas that has no smell when it is in its pure form;
8) It has been in use for so long because it is found by itself as a pure element;
9) When purified, it is a grayish, shiny metal;
10) Almost eighty percent of Earth's atmosphere is made of its gas;
11) Though it is known as a magnetic metal, not all forms of iron are magnetic;
12) It is the seventh element of the periodic table located between carbon and oxygen.

Exercise 12. *Match the beginnings of the sentences with their endings.*

1) Iron is found	a) other elements including hydrogen.
2) There is iron in	b) the variety of places copper is used in nature.
3) Iron oxidizes easily and the resulting compound	c) essential in most of the compounds that allow life to exist.
4) Just digging in a mine people came across	d) pure copper in a variety of forms.
5) The thing under discovering is	e) is known as rust.
6) Along with carbon and oxygen, nitrogen is	f) computers, desks, and even human body.
7) Nitrogen can create very reactive compounds when combined with	g) all over the Earth and the Universe.

Exercise 13. *Translate the following text. In pairs, ask and answered questions about the halogen group and its chemical properties.*

Halogens

In chemistry halogens is a group of five closely related chemically active elements: fluorine, chlorine, iodine, and astatine. The name halogen came from the Greek *hals* meaning "salt" and genes meaning "born".

Iodine is a blue-black solid at room temperature. It was first isolated from seaweed residues in 1811 by Bernard Courtois. It sublimes when heated, giving off a violet vapor with a stinging odor like that of chlorine. The element, in pure form, is poisonous. Like all halogens, it is chemically active. It is only slightly soluble in water, but it is soluble in alcohol, chloroform, and other organic reagents. Iodine is a relatively rare element, ranking about 62nd in abundance on earth, but its compounds are widespread in seawater, soil, and rocks. Iodine is medicinally very important because it is an essential trace element, and is involved in growth-controlling and other metabolic functions. In medicine, iodine-alcohol solutions and iodine complexes have been used as antiseptics and disinfectants. More broadly, various iodine compounds find use in photography and making of dyes.

Chlorine, the atomic number 17, was first isolated in 1774 by the Swedish chemist Carl Wilhelm Scheele. At ordinary temperatures, chlorine is a greenish-yellow gas that can readily be liquefied under pressure. The gas has an irritating odor and in large concentration is dangerous; it was the first substance used as a poison gas in World War I. Free chlorine does not occur in nature, but its compounds are common minerals. Chlorine is an

active element, reacting with water, organic compounds, and many metals. Chlorine and hydrogen can be kept together in the dark, but react explosively in the presence of light. Chlorine solutions in water are familiar in the home as bleaching agents.

Astatine is the heaviest of the halogens. It is the halogen that behaves most like a metal and that has only radioactive isotopes. It is highly carcinogenic.

Bromine, poisonous element that at room temperature is dark, reddish-brown liquid. Bromine is widely distributed in nature. At room temperature, bromine is an extremely volatile liquid, giving off a poisonous, suffocating, reddish vapor composed of diatomic molecules. if the liquid comes in contact with the skin, it causes sores that heal very slowly. Bromine is slightly soluble in water, but it is very soluble in a wide variety of organic solvents, such as alcohol, ether, chloroform, and carbon disulfide.

Bromine does not occur in nature as a free element. It is used in photographic compounds and in natural gas and oil production.

Fluorine is chemically reactive, poisonous gaseous element. The element was first isolated in 1886 by the French chemist Henri Moissan. It is a pale, greenish-yellow gas, slightly heavier than air, poisonous, corrosive, and of penetrating and disagreeable odor. It is the most chemically active of the nonmetallic elements. It combines directly with most elements and indirectly with nitrogen, chlorine, and oxygen. Nearly all compounds are decomposed by fluorine to form fluorides that are among the most stable of all chemical compounds. It is the 17th element in order of abundance in the crust of the earth. The chlorofluorocarbons, odorless and nonpoisonous liquids or gases such as Freon, are used as a dispersing agent in aerosol sprays and as a refrigerant.

Exercise 14. *Find the Ukrainian equivalents to the following word combinations from the text.*

Closely related chemically active elements; a stinging odor; slightly soluble in water; a relatively rare element; widespread in seawater, soil, and rocks; an essential trace element; to be liquefied under pressure; an irritating odor; to react explosively in the presence of light; bleaching agent; widely distributed in nature; contact with the skin; slightly heavier than air; penetrating and disagreeable odor.

Exercise 15. *Describe the properties of one element from the list: a) Iodine; b) Chlorine; c) Astatine; d) Bromine; e) Fluorine.*

Exercise 16. *Read and memorize the information about chemical nomenclature and the basic rules of reading chemical compounds.*

Chemical nomenclature is done according to the rules recommended by International Union of Pure and Applied Chemistry (IUPAC). The names of chemical elements originated from the Latin stems because of an old tradition to use this language in science and in chemistry. Traditional names are also encountered in the English language. For instance, alkaline metals with Latin names kalium and natrium are usually called «potassium» and «sodium». The noble metals and some other elements have traditional English names also. For instance, Au ("gold" and "aurum"); Ag ("silver" and "argentum"); Cu ("copper" and "cuprum"); Fe ("iron" and "ferrum") etc. The symbols of the chemical elements in use today were introduced into science by J. Berzelius in 1813. He proposed to designate the elements by the initial letters of their Latin names. When the names of several elements begin with the same letter, one of the following letters is added to the first one.

Systems of chemical nomenclature

There are about several millions chemical compounds discovered by chemists today. That is why systems of naming were devised to prevent total confusion. The most serious thing is with binary compounds.

A binary compound is a compound that consists of a combination of two elements. Compounds that end in *ide* indicate that they contain only two elements. The first element should be named at first, while the second element consists of the stem plus the suffix *ide* that are placed in the second part of the binary compound's name. The stems of the most commonly used elements are:

Oxygen - ox, Chlorine - chlor, Carbon - curb, Nitrogen - nitr, Phosphorus - phosph, Fluorine -fluor, Sulfur - sulf.

Examples: HC1 - hydrogen chloride; AIN - aluminum nitride; K_2S - potassium sulfide; KCN - potassium cyanide; $BeCl_2$ - beryllium chloride, etc.

To denote one through ten atoms in a formula of a compound the following Greek names of the prefixes are used: *1 (mono-), 2 (di-), 3 (tri-), 4](,tetra-), 5 (penta-), 6 (hexa-), 7 (hepta-), 8 (octa~), 9 (nona-), 10 (deca-).*

The prefix for one (mono-) is omitted except when its presence is necessary to avoid confusion.

Examples:

N_20_4 dinitrogen tetroxide;
CO carbon monoxide;
PCI_3 phosphorus trichloride;
CO_2 carbon dioxide;
P_4O_{10} tetraphosphorus decaoxide;
CaO calcium oxide;
XeF_4 xenon tetrafluoride.

A number of well-established nonsystematic names that continue to used simply need to be memorized. These include:
H_20 water; N_2H_4 hydrasine; NH_3 ammonia; PH_3 phosphine; AsH_3 arsine.

Exercise 17. *Write chemical formula as requested.*

lead, sodium chloride, copper (I) sulfide, uranium hexafluoride, calcium hydroxide, aluminum oxide, magnesium bromide, calcium chloride, etic acid, sulfurous acid, iron (II) chloride, hydrogen gas, ammonia, chlorine, tungsten (V) iodide.

Exercise 18. *Make a table of the main rules of reading chemical elements and compounds. Add your own examples to complete the table.*

Exercise 19. *Write a short summary of the importance of the modern periodic table of elements and explain how the elements are arranged there and what the properties of each family are.*

UNIT 7
THE ESSENCE OF MATTER

Exercise 1. *Learn the following words and word combinations:*
original thinker - визначний мислитель
logical basis - логічна підстава
whims of gods and goddesses - примхи богів та богинь
conceive - збагнути, зрозуміти, уявляти собі
essence of all matter - сутність усієї матерії
solar eclipse - сонячне затемнення
naval battle - битва на морі
to make a prediction - робити передбачення, передбачати
successor - послідовник, наступник
primordial element - первісний елемент
enunciate - проголошувати, формулювати (про теорію)
coherent atomic cosmology - чітка атомістична космологія
smooth - гладенький, рівний
slippery - слизький
jagged with hooks - зазублений
contrary qualities - протилежні якості
opposite edges - протилежні краї
extent and movement - спокій та рух
ridiculous - безглуздий

Exercise 2. *Make a "map" of your knowledge about the changes in scientific understanding of the essence of matter. Answer the following questions: What do I know about: 1) scientists who dealt with the problem of matter; 2) the development of notion about the matter; 3) the theory about four primordial elements of matter.*

Exercise 3. *Read and translate the text on essence of matter. Check whether your knowledge is true.*

The Essence of Matter; Four Elements

The ancient Greek philosophers were not scientists. They were, however, original thinkers who attempted to explain nature on a logical basis rather than by the whims of gods and goddesses. The father of this movement is considered to be Thales of Miletus, and during the sixth ntury B.C., he conceived of water as the essence of all matter. Thales is putted to have predicted the total solar eclipse of 585 B.C., said to have ocurred during a naval battle—although there is no basis for him having the

knowledge to make such a prediction.

One of his successors in the Milesian School was Empedocles of Agrigentum (ca. 490-430 B.C.). Empedocles is said to be the first to propose at all matter is composed of four primordial elements of equal importance, though similar ideas appear to have formed in Egypt, India, and China five elements) around 1500 B.C.

Only during the fifth century B.C. two philosophers of the Milesian School enunciated a coherent atomic cosmology. For these scholars there re two realities in nature: Atoms (atoms, meaning not cuttable) and Void (derived from vacuous, meaning empty). Void was considered to be as real Atoms. Atoms of water were thought to be smooth and slippery; those of iron were jagged with hooks.

Aristotle proposed a kind of primordial, heavenly element, "ether," to each of the four earthly elements attributed two pairs of opposite or contrary "qualities" (wet versus dry; hot versus cold). The relationships between the elements and their qualities are depicted in a square that nicely ces contrary qualities on opposite edges. The square is one of the fundamental symbols that often appeared in alchemical manuscripts and books even as late as the eighteenth century.

Aristotle was an anti-Atomist, in part, because he did not believe space could be empty. The great mathematician and philosopher Rene Descartes (1596-1650) who envisioned only two principles in matter (extent movement) and rejected the four Aristotelian qualities adopted this view, idea of extent led him to reject the idea of finite atoms and the concept void he considered ridiculous.

Exercise 4. *Answer the following questions.*

1. How did the first philosophers try to explain the nature? 2. Who is considered to be the father of the logical basis of nature movement? 3. What was the essence of all matter according to Thales of Miletus? 4. What prediction did he make? 5. Who was the first to propose the four-element composition of matter theory? 6. Name those elements. 7. What did the Milesian School philosophers enunciate? 8. What were the two realities in nature? 8. What did Aristotle propose? 9. Who rejected the Aristotelian theory?

Exercise *5. Write out verb forms except the verb to be and define their tense and voice forms, give the Infinitive.*

Example: was given - Past Simple, Passive Voice - to be given.

Exercise 6. *Give Ukrainian equivalents to the following expressions. Find them in the text and compose your own sentences with these expressions.*

Ancient Greek philosophers, attempted to explain nature, whims of gods and goddesses, the father of this movement, to be of equal importance, similar ideas, to be as real as, heavenly element, versus, fundamental symbols, alchemical manuscripts.

Exercise 7. *State whether the following sentences are true or false. Correct the false ones.*

1. The ancient Greek philosophers were not scholars. 2. The father of the movement about logical basis of nature is considered to be Aristotle. 3. Thales is believed to have predicted the partial solar eclipse of 585 B.C., said to have occurred during a naval battle. 4. Empedocles is said to be the first to propose that all matter is composed of fourteen primordial elements of equal importance. 5. Although similar ideas appear to have formed in Egypt, Asia, and China (five elements) around 1500 B.C. 6. Void was considered to be as real as Atoms. 6. The square is the only fundamental symbol that often appears in alchemical manuscripts and books. 7. Aristotle was an anti-Atomist, in part, because he did not believe that space could be empty.

Exercise 8. *Make up sentences putting the words in the correct order.*

1. and eighteenth centuries/ In the seventeenth/ conflict between the Cartesians (school of Descartes)/ there was intellectual/ and the Corpuscular school/ Robert Boyle and/which included/ Isaac Newton.
2. cold and wet/ A liquid/ while its vapor/ (rich in water)/ is /(rich in air)/ is hot and wet.
3. of the square/ simply add heat — /To vaporize a liquid/ the cold edge/ move from / to the hot edge.
4. add hot / To dissolve / (rich in earth) / a solid, add wet/ to bum the solid.
5. propounded by Lavoisier/ Fire / liquid /or gas/of internal energy-/ related to the eighteenth-century/
   but a form / concept of “caloric”/ was not solid.
6. and water/ Moat prominent/ whose activities/ are/ symbolize earth/ the four abbots/ fire/ air.
7. of the seventeenth century/ Although/ date to/ the earliest writings/ the beginning.
8. the true founder/ Some/ the early sixteenth-century/ consider/

Paracelsus/ physician and alchemist/
to be.

Exercise 9. *Match the verbs and the prepositions they are used with:*

to derive	about
to combine	on
to conceive	of
to compose	with
to place	of
to think	from
to believe	in

Exercise 10. *Fill in the gaps with the following words and word combinations.*

triangles and squares, Material Body, female, exalted mercury, earlier view of matter, Renaissance, triangle, Spirit, characterized, exalted sulfur, were, challenged

During the _____, the classical Greek views of nature _____ finally _____ by the likes of Paracelsus. He extended an _____ that held that it was a union between an _____ of the philosophers ("Sophie Sulfur" -_____ often as male) and an _____ of the philosophers ("Sophie Mercury" - characterized often as _____). These are not related to the chemical elements now recognized as sulfur and mercury. To these Paracelsus added Salt as the third Principle. So Mercury is _____, Sulfur is Soul, and Salt is _____. The relationship is depicted as a _____, the other great metaphor found in alchemical manuscripts through the 18th century. All matter is composed of these three principles in various proportions. They make a symbolic triangles - the bottom triangle presents Life, Spirit, Body (or Fire, Air, Water or Animal, Vegetable, Mineral). Symbols of _____ abound in alchemy.

Exercise 11. *Make up as many questions to the following sentences as possible.*

1. The electrons are considered to be fundamental particles of infinite lifetime. 2. Protons and neutrons are not fundamental and are two of a very complex class of subatomic particles called hadrons. 3. Outside of the nucleus, a free neutron has a half-life of only 17 minutes and decays into a proton. 4. An atom is divisible. 5. The positive nucleus and the negative electrons are our modern "contraries."

Exercise 12. *Translate into English paying special attention to the italicized words.*

1. Давньогрецькі філософи були першими, хто намагався логічно пояснити природу та її компоненти. 2. Засновником руху про логічний початок природи вважається Тілій з Мілету. 3. Повне сонячне затемнення 585 року до н.е. під час морської битви було передбачене завдяки використанню логічного підходу у науці. 4. Емпідокл був першим, хто запропонував концепцію первісних елементів матерії. 5. Філософами Мілецької школи було запропоновано чітку атомістичну космологію у п'ятому столітті до н.е. 6. Вважалося, що вода має гладенькі та слизькі атоми, у той час, як атоми заліза є зазубленими. 7. Аристотель був першим, хто на додачу до чотирьох первісних елементів запропонував п'ятий - небесний елемент - ефір.

Exercise 13. *Complete the definitions:*

Original thinker - a person, who ...
Nature - everything in the physical world that ...
Matter – a material that...
Solar eclipse - a natural phenomenon when ...
Prediction - a saying that ...
Primordial elements - the first elements that are ...
Atomic cosmology - a theory that is ...
Heavenly element - an element that...

UNIT 8
CLASSIFICATION OF MATTER

Exercise 1. *Learn the following words and word combinations:*

mass - маса
volume – об'єм
inertia – інерція
solids – тверді тіла
liquids - рідини
hierarchy – ієрархія
substance – речовина
mixture – суміш
constant composition – незмінний склад
to break down – розпадатися, розкладатися
homogeneous – однорідний (гомогенний)
heterogeneous – різнорідний (гетерогенний)
uniform – одноманітний, постійний, сталий
metal alloys – сплави металів
solute – розчинена речовина
solvent – розчинник
to be well blended – бути добре змішаним

Exercise 2. *Read, translate the text and fill the chart below according to the text.*

Anything that has mass and volume is matter. Matter is also defined as anything with the property of inertia. All of the solid, liquids and gases in daily life can be classified as some type of matter. One useful way of organizing our understanding of matter is to think of a hierarchy that extends down from the most general and complex to the simplest and most fundamental. All matter is accepted to classify into substances and mixtures. Substance is a material with a constant composition. This means that the substance is the same no matter where it is found. NaCl, H_2O, Ne, CO_2, and O_2 are all substances, because their composition will be the same no matter where you find them. All elements and all compositions are defined as substances.

Elements are substances that are made up of only one type of atom. At this time, there are 113 known elements, most of which are metals. The symbols shown on the periodic table represent the known elements. Gold, silver, carbon, oxygen and hydrogen are the examples of elements. However, atoms consist of smaller particles, but they are not broken down

by ordinary chemical means. Compounds are substances that are made up of more than one type of atom. Water, for example, is made up of hydrogen and oxygen atoms. Carbon dioxide is made up of carbon and oxygen atoms. Table salt is made up of sodium and chlorine. Unlike elements, compounds can be decomposed, or broken down by simple chemical reactions.

Compounds differ from mixtures because they are chemically combined, unlike mixtures - two or more substances that are physically combined. Some mixtures are so well blended that they are considered homogeneous, being made up of only one phase (salt water, pure air, metal alloys, seltzer water). Other mixtures, containing more than one phase, are called heterogeneous (sand, soil, chicken soup, pizza, chocolate chip cookies).

Any material that contains only one phase would be considered homogeneous. Elements like hydrogen, compounds like sugar, and solutions like salt water, are all considered homogeneous because they are uniform. Each region of a sample is identical to all other regions of the same sample. Solutions are a special type of homogeneous material, because unlike compounds, the parts of a solution are physically, not chemically, combined. When you mix a glass of salt water, the salt does not chemically react with the water. The two parts just mix so well that the resultant solution is said to be uniform. Ice tea, coffee, metal alloys, and the air we breathe are some examples of solutions. Solutions are made up of two parts: the solute, which gets dissolved, and the solvent, which does the dissolving. In the case of salt water, salt is the solute and water is the solvent.

Heterogeneous mixtures are made up of more than one phase and they can be separated physically. The chocolate chip cookie, a tossed salad, sand, and a bowl of raisin bran cereal are all examples of obvious heterogeneous mixtures.

Matter			
Substance			
Element		Heterogeneous	
	Ex.: water		Ex.: salt water

Exercise 3. *Match the terms with their definitions:*

Matter

Compound

Substance
Heterogeneous Mixture
Mixture
Homogeneous Mixture
Element
Also called solutions. Mixtures that are made up of only one phase;
Matter with variable composition;
Two or more elements that are chemically combined;
Mixtures that are made up of more than one phase;
Matter with constant composition;
Anything with mass and volume;
Substance made up of only one type of atom.

Exercise 4. *Answer the following questions.*

1. What is matter? Give an example of matter. 2. What two classes can all matter be classified? 3. What class do elements and mixtures belong to? 4. What do we understand under the term element? 5. Yow many elements are discovered at present? 6. What is the difference between elements and compounds? 7. What can not be broken down by ordinary chemical means? 8. What consists of more than one type of atoms? 9. What is mixture? 10. What types of mixtures do you know? 11. What matter can be considered homogeneous and why?

Exercise 5. *Divide given matter into four groups: elements, compounds, heterogeneous and homogeneous mixtures.*

Silicon, water, alcohol, radon, oil, carbon dioxide, yttrium, hydrogen oxide, silicon dioxide, tin, methane, zinc, air, soil, smoke, boron, salt water, hydrogen peroxide, gold, acetic acid, iodine, sugar, gasoline.

Exercise 6. *A) Write out English equivalents of the following word combinations.*

Змішувати, суміш, плавити, випаровуватися, сплав, визначати, сполучатися, перетворюватися, реагувати, класифікувати, відкривати (робити відкриття), виміряти, зазнавати змін, призводити, розкладатися, відокремлювати, конденсуватися, тверднути, охолоджуватися, дистилюватися, нагрівати, вимірювати температуру.

B) Describe the experiment of water distillation using words given above.

Exercise 7. *Find from the list the words with nearly the same or opposite meanings to the initial ones.*

Liquid, characteristic, matter, pure, simple, change, break down, constant, general

Fluid, mere, variable, compose, property, solid, impure, stability, clean, special, material, emptiness, decompose, commonness, uniform, ordinary, complex, transformation.

Exercise 8. *Translate the words in brackets into English. Give the title to the text.*

(За нормального тиску), pure water (кипить) at 100°C. As boiling continues, the (температура залишається) at 100° until all of the liquid has been changed to a gas. Pure water (не може бути відокремлена) into separate parts (фізичною зміною). Water from the ocean (salt water) is different. Not only does it boil (при вищій температурі), but the boiling temperature (постійно зростає) as the boiling proceeds. If boiled long enough, the water (википає) as a gas and the salt is left behind (у вигляді твердої речовини). The properties of pure water and ocean water (ілюструють різницю) between pure substance and a mixture. A pure substance is a single chemical, one kind of matter. It has its (власний набір фізичних і хімічних властивостей), not exactly the same as the properties of any other pure substance. These properties may be used to (для визначення речовини). The word ***mixture*** has already been used to (для опису частини речовини) that consists of two or more different chemicals. (Властивості сумішей залежать від) the substances in it. These properties (коливаються) as the relative amounts of the different parts (змінюються). The pure substances in a mixture may be separated by physical changes, as salt and water are separated by boiling off the water.

Exercise 9. *Translate into English.*

1. Властивості розчину залежать від відносної кількості його компонентів. 2. Будь-що, що має масу й об'єм, є матерією. 3. За її будовою матерію класифікують на чотири групи: елементи, сполуки, розчини та гетерогенні суміші. 4. Всі елементи та сполуки є речовинами. 5. Матерія утворює світ навколо нас. 6. Класифікація матерії на речовини та суміші, заснована на стабільності структури, є більш корисною для хіміків. 7. Елементом є чиста речовина, яка не може бути поділена на прості речовини шляхом звичайних хімічних змін. 8. Більшість матерії існує у вигляді сполук - поєднанні атомів

або протилежно заряджених іонів двох чи більше різних елементів. 9. Суміші відображають властивості, що коливаються з залежності від зміни пропорції компонентів у їх складі.

Exercise 10. *Apart from direct meaning in chemistry, the following words element and matter have indirect one.*

A) Read the sentences and the explanations to them and insert the underlined words to give them a proper sense;

1. Tom came off the field, surrounded by reporters and shaking hands with team-mates – he was in his _____. (to be in your _____ means to be in a situation that you are familiar with and are good at dealing with).

2. A large company should supply the customers with all information as the _____ of course. (as a _____ of course means to be normally done that way).

3. Officials offered free tickets to fans in Orlando who braved the _____s. (to brave the _____s means to go out when the weather is bad).

4. News about the last experiment is no laughing _____ for the hundreds of scientists who protested against it. (to be no laughing _____ is used in order to say that a situation is serious).

B) Compose the sentences of your own with the given idioms.

Exercise 11. *Match the beginnings of the sentences with their right endings.*

1. There are two kinds	a) of pure substances.
2. Among chemical properties of silver is that	b) set of physical and chemical properties.
3. Like all pure substances, silver has its own unique	c) it cannot be decomposed or separated into other stable pure substances, either chemically or physically
4. This identifies silver	d) as an element.
5. Nature provides us with	e) kind of pure substance.
6. Most of the earth's crust is made up of compounds	f) decomposed into other pure substance.
7. Water represents the second	g) a chemical change into two or more other pure substances is a compound.
8. Unlike silver, water can be	h) at least 88 elements.
9. Any pure substance that can be decomposed by	i) containing a relatively small number of these elements.
10. Nitrogen, oxygen and argon	

11. Copper, sulfur, silver and gold	j) are among the few well-known solid elements that occur uncombined in nature. k) make up about 98% of air at the surface of the earth.

Exercise 12. *Make the plan of the text* ***Classification of Matter*** *and retell the text.*

Exercise 13. Read and translate the text. Put the paragraphs in the right order to correspond to the plan: a) The abundance of solutions in nature; b) Different water solutions and their characteristics; c) A solutions as a homogeneous mixture; d) the determination of physical properties by the composition; e) Three stages of solution existence.

The Characteristics of the Solution

(1) Even what we call "fresh" water is a solution, although the concentrations are so low we tend to think of the water we drink as "pure". "Hard" water may be pure enough for human consumption, but there are enough calcium and magnesium salts present to form solid deposits in hot water pipes and boilers. Even rainwater is a solution; it contains dissolved gases. Oxygen is not very soluble in water, but what little there is in solution is mighty important to fish, who cannot survive without it.

(2) A solution may exist in any of the three states, gas, liquid, or solid. Air is a gas solution, made up of nitrogen, oxygen, argon, and other gases in small amounts. In addition to oxygen in water, dissolved carbone dioxide in carbonated beverages is a familiar liquids and the oceans are liquid solutions of solids. Solid state solutions are common in the form of metal alloys.

(3) A solution of ammonia in water, for example, may contains 1% ammonia by weight, or 2%, 5%, 20,3% … up to 29% solution called "concentrated ammonia." This leads to variable physical properties, which are determined by the composition of a mixture.

(4) Solutions abound in nature. We are surrounded by the gaseous solution known as air. The oceans are aqueous (water) solutions of sodium chloride and other substances. Some of these substances are present in sufficient concentrations to make it commercially profitable to extract them. Magnesium is a notable example.

(5) Solution is characterized by the uniform distribution of solution components, so that a sample taken from any part of the solution will have

the same composition. Two solutions made up of the same substances, however, may have different compositions.

Exercise 14. *Find in the text words and word combinations with the following meanings:*

Рясніти (бути поширеним), газові розчини, водні розчини, в достатній концентрації, яскравий приклад, питна вода, важка вода, для людського споживання, утворювати тверді поклади, розчинені гази, розчинний у воді, рівномірний розподіл, у малих кількостях.

Exercise 15. *Describe different solutions using suggested words and word combinations.*

"Fresh" water	*Solution, concentration, pure, "hard" water, for human consumption, calcium and magnesium salts, to form solid deposits*
Rainwater	*Solution, contain, dissolved gases, Oxygen, soluble, mighty important to fish, survive*
Ocean water	*Liquid solution, many solids, solution components, aqueous, sodium chloride, to be present in sufficient concentrations, commercially profitable, to extract, magnesium*
Air	*Solution, concentration, pure, contain, Oxygen, survive, gaseous, nitrogen, argon, in small amounts*

Exercise 16. *Match the terms with their definitions:*

Solid solution	*A strong solution that contains a large amount of solute.*
Solute	*A solution that cannot hold any more solute at a definite temperature.*
Solution	*Any liquid that dissolves another solute and first solvent and in which the solute is more soluble.*
Concentrated solution	*Any stabilizing interaction of a solute with the solvent, or a similar interaction of solvent with groups of an insoluble material (i.e., the ionic groups of an ion-exchange resin).*
Salvation	*Any liquid mixture of two or more substances that is homogeneous.*
Solvent	*Any dissolved substance in a solution.*
Saturated solution	*A homogeneous mixture of two or more components; a main component and (normally) a*

Dilute solution	*small amount of another component exist within the crystal structure of the main component.* *A weak solution that contains little solute.*

Exercise 17. *Insert the words into the text according to their meanings.*

Solute* and *Solvent

When solids or gases are dissolved in liquids, the solid or gas is said to be the _____ and the liquid the _____. More generally, the _____ is taken to be the substance present in a relatively small amount. The medium in which the _____ is dissolved is the _____. The distinction is not precise, however. Water is capable of dissolving more than its own weight of some solids, but the water continues to be called the _____. In alcohol-water solutions, either liquid may be the more abundant and, in a given context, either might be called the _____or _____.

Concentrated and Dilute

A _____solution has a relatively large quantity of a specific solute per unit amount of solution, and a _____ solution has a relatively small quantity of the same solute per unit amount of solution. The terms compare concentrations of two solutions of the same solute and solvent. They carry no other quantitative meaning.

Solubility, Saturated, Unsaturated* and *Supersaturated

_____is a measure of how much solute will dissolve in a given amount of solvent at a given temperature. It is sometimes expressed by giving the number of grams of solute that will dissolve in 100 grams of solvent. A solution that can exist in equilibrium with undissolved solute is a _____solution: A solution whose concentration corresponds to the _____limit is therefore_____. If the concentration of a solute is less than the _____ limit, it is _____. Under carefully controlled conditions, a solution can be produced in which the concentration of solute is greater than the normal _____ limit. Such a solution is said to be _____. A _____ solution of sodium acetate, for example, may be prepared by dissolving 80 g of the salt in 100 g of water at about 50°C. If the solution is then cooled to 20°C without stirring, shaking, or other disturbance, all 80 g of solute will remain in solution.

Exercise 18. *Translate the text into English paying special attention to the active vocabulary of the lesson.*

Матерією вважають усе те, що має масу та об'єм. Вчені поділяють всю матерію на чотири великі групи: елементи і сполуки, що належать до класу речовин, та гетерогенні і гомогенні суміші, що є представниками класу сумішей. На відміну від елементів, які складаються лише з одного типу атомів, сполуки містять більше одного виду атомів, а тому їх легко розділити простими хімічними реакціями.

Фізично поєднані речовини утворюють суміші, до яких і належать розчини - особливий вид гомогенних сумішей, що характеризується однорідним розміщенням складових компонентів. Розчини складаються з двох частин: розчиненої рідини та розчинника, розчинником називають середовище, в якому розчиняється певна кість іншої речовини — розчиненої речовини. Залежно від кількості розчиненої речовини розчини поділяють на концентровані і розбавлені.

Exercise 19. *Insert the appropriate name of the element or solution get the right meaning of the proverbs. Translate the proverbs and use in situation of your own.*

Gold, steel, air, diamond, salt, iron, silver,
marble, diamond, coal, water

To de as true as_____;
There has been much _____ eaten since that time;
Strike the _____while it is hot;
Blood is sicker than _____;
Every cloud has a _____lining;
_____cut _____;
To be as cold as _____;
To carry _____ to Newcastle;
To beat the _____;
All is not _____that glitters.

UNIT 9
PROPERTIES AND STATES OF MATTER

Exercise 1. *Learn the following words and word combinations:*

to undergo various changes - зазнавати різних змін
to identify - визначати
to associate with - з'єднуватись, сполучатися
charcoal - деревне вугілля
bread dough - тісто на хліб
to substitute - заміняти
to distinguish - відрізнятися
to measure - вимірювати
to boil (boiling point) - кипіти (точка кипіння)
to melt (melting point) - танути (точка танення)
versus - проти (у порівнянні)
density - густина
to alter the physical form - змінювати фізичну форму
to refreeze - заморожувати повторно
to recover - повертати назад, відновлювати
to detect - встановлювати, визначати
to react violently with — дуже сильно реагувати з
to dissolve in liquid - розчинятися в рідині
to model the substance - уявляти (чітко формувати) речовину
to behave under various conditions - поводитися за різних умов

Exercise 2. *Read, translate the text and fill the chart below according to the text.*

Physical and Chemical Properties of Matter

Chemistry is partly the study of the transformations that matter can undergo. Any substance is known to undergo various changes of composition. All substances have properties that we can use to identify them. For example, we can identify a person by their face, their voice, height, finger prints, DNA etc. The more of these properties we can identify, the better we know the person. In a similar way matter has properties.

There are two basic types of properties that we can associate with matter. These properties are called physical properties and chemical properties. Physical properties do not change the chemical nature of matter.

Describing a bit of matter, it is more convenient to list its physical properties. Charcoal is black, sulfur is yellow. Glass is hard, bread dough is

soft, and concentrated sulfuric acid hurts. Taste is *definitely not recommended* for describing laboratory chemicals, but for food chemists there is no substitute for distinguishing between things that are salty or sweet. Other physical properties are measured in the laboratory. For example, the temperature at which a substance boils or melts, called the *boiling point* or *melting point.* The relative "heaviness" of two substances, like lead versus aluminum, compares their *densities.*

Changes that alter the physical form of matter without changing its chemical identity are called physical changes. The melting of ice is a physical change, as is the freezing of liquid water. The substance is water both after the melt and after it is refrozen. Dissolving sugar in water is another physical change. The sugar seems to disappear, but if you taste the water, you'll know the sugar is there. The dissolved sugar can be recovered by evaporating the water, another physical change.

A chemical change occurs when the chemical identity of a substance is destroyed and a new substance is formed. A chemical change is also called a chemical reaction. Chemical changes can usually be detected by one or more of the five physical senses. A change of color almost always indicates chemical change, as in toasting bread. One can feel the heat and see the light given off as a match burns. One can smell milk that becomes sour. Explosions usually give off sound. So, chemical properties usually refer to changes in composition that a substance can undergo.

For example, there are some of the most distinctive physical and chemical properties of sodium:

physical properties (25°C) - appearance: a soft, shiny metal, density: 0.97 g cm^3, melting point: 97.5°C, boiling point: 960°C;

chemical properties - forms an oxide Na_20 and a hydride NaH, burns in air to form sodium peroxide Na_20_2, reacts violently with water to release hydrogen gas, dissolves in liquid ammonia to form a deep blue solution.

The more properties a scientist can identify for a substance, the better he knows the nature of that substance. These properties can then help model the substance and thus understand how this substance will behave under various conditions.

Exercise 3. *Answer the questions to the text.*

1. What is a subject of chemical studying? 2. How can we identify a substance? 3. What are two basic properties associated with matter? 4. What properties do we usually use to describe a matter? 5. What physical properties can be measured in the laboratory? 6. What are physical

changes? Give an example of a physical change. 7. When does a chemical change occur? 8. What is other name of a chemical change? 9. How can a chemical change be detected? Give an example of a chemical change. 10. State the most distinctive physical and chemical properties of sodium. 11. What helps a scientist to identify a substance?

Exercise 4. *Make the plan of the text and state what paragraph (may be more than one) the following key words can belong to:*

Dissolving sugar; the transformations that matter can undergo; not change the chemical nature of matter; distinguishing between things; melting point; changing chemical identity; chemical reaction; changes in composition; behave under various conditions; to release hydrogen gas; one more of the five physical senses; density; boiling point; to list physical properties; to undergo various changes of composition.

Exercise 5. *Match the verb in A to a noun in B.*

A	B
to undergo	under various
to behave	conditions
to identify	sound
to give off	the nature of matter
to change	hydrogen gas
to release	physical properties
to list	violently with water
to react	the form of matter
to alter	in liquid
to dissolve	a chemical change
to detect	a deep blue solution
to model	by physical senses
to indicate	the substance
to form	various changes
	Properties

Exercise 6. *Choose physical and chemical properties from the list below and complete the chart.*

Physical property	Chemical property
1……..	

Color, boiling point, attraction (paramagnetic) or repulsion (diamagnetic) to magnets, density, electromotive force, freezing point, infrared spectrum, viscosity, reactivity with water, smell, melting point, opacity, heat of combustion, PH.

Exercise 7. *A)_Classify each of the statements as a physical or chemical property, and explain the basis for your answer;*

1. Chlorine is a greenish-yellow gas at room temperature.
2. Liquid oxygen is attracted by a magnet.
3. Gold is highly resistant to corrosion.
4. Hydrogen cyanide is an extremely poisonous gas.
5. Sugar is a high-energy food.

B) Read the explanations and check your answers.

a) This is another way of stating that the boiling point (a physical property) is below 20°C.
b) Even under the influence of the magnet, the oxygen is still the same substance, 02, so the effect is purely a physical property.
c) Corrosion involves the reaction of a metal with oxygen and water, so corrosion (and by extension, resistance to corrosion) is definitely a chemical property.
d) Most poisonous substances act by combining chemically with substances that interfere with some aspect of cellular biochemistry, so we can consider this to be a chemical property of HCN.
e) The chemical energy contained in a food or fuel can be released only through a chemical reaction leading to lower-energy products. The “high-energy” part might be considered a physical property, since this depends on the quantity of energy obtainable from a given mass of the substance.

Exercise 8. *Read the definitions and find the terms in the text they refer to.*

- A complete change in someone or something;
- The way in which something is made up of different parts, things or members;
- A qualities or power that a substance has;
- The qualities or features that something has;
- A thing that you use instead of the one that you usually have, because the usual one is not available.

Exercise 9. *Read the physical properties of matter and find their explanations.*

Color	*Conductivity*	*Density*
Odor	*Hardness*	*Mass*
Luster	*Melting /*	*Weight*
Malleability	*(Freezing Point)*	*Volume*
Ductility	*Boiling Point*	*Length*

A measurement of the amount of space a substance occupies;
A measurement of the gravitational force of attraction of the earth acting on an object;
A measurement of the amount of matter in an object (grams);
The temperature at which the vapor pressure of a liquid is equal to the pressure on the liquid (generally atmospheric pressure)
The mass of a substance divided by its volume;
How easily a substance can be scratched;
The temperature at which the solid and liquid phases of a substance are in equilibrium at atmospheric pressure;
The ability of a substance to allow the flow of energy or electricity;
The ability of a substance to be beaten into thin sheets;
The ability of a substance to be drawn into thin wires;
How shiny a substance is;
The appearance of something as a result of the way it reflects light;
A smell;
A measurement of how long something is from one end to the other.

Exercise 10. *Insert the missing words and word combinations into the text.*

yields, mass, reflect, grams/milliliter, cubic centimeters, units, heavier, mass per unit volume, physical property, volume, low, expressed, grams per cubic centimeter, measured, of the same size, relative "heaviness", substance

Density

Density is an example of the combination of base units to define a _____ of a pure_____. The formal definition of density is_____. We can think of density as a measure of the _____of a substance, in the sense that a block of iron is _____than a block of aluminum _____. The definition of density establishes its _____. Mass is commonly _____ in

grams (g); volume is measured in _____(cm^3). Therefore, according to the "mass per unit volume" definition, the units of density are _____, g/cm^3. Liquid densities are often given in _____, g/mL. There are, of course, other units in which density can be_____, but they all must _____the definition in terms of
mass/volume. Examples are grams/liter, usually used for gases because their densities are so _____, and the English pounds/cubic foot.

In order to find the density of a substance, it is necessary to know both the _____ and _____of a sample of the substance. Dividing mass by volume _____ density.

Exercise 11. *Translate into English.*

Вся матерія може зазнавати фізичних та хімічних змін. Результатом фізичних змін не є утворення нової речовини. Ці зміни оборотні. Тобто, фізичними змінами можна назвати всі зміни стану речовини, наприклад, замерзання води, змішування речовин, розривання на шматки тощо. На противагу фізичним, хімічні утворюють зміни природи або складу речовини. Результатом хімічних змін завжди є утворення речовин з новими хімічними властивостями, наприклад, горіння твердого палива, що призводить до утворення газу діоксину карбону. Всі речовини можуть бути визначені на основі їх фізичних і хімічних властивостей. Розмір, колір, смак, запах, стан, здатність проводити енергію, гнучкість, крихкість є фізичними властивостями. До хімічних же ми можемо віднести здатність до згоряння, ржавіння, вибухова сила тощо.

Exercise 12. *Work in pairs and act out a situation at your choice. You are a well-known scientist who is now working on the problem of physical and chemical properties of:*

a) silver, b) sulfur; c) oxygen; d) water; e) syrup; f) iron.

Give an interview to a local newspaper revealing the results of your work.

Exercise 13. *Read the text and insert the phrases to connect the text.*

Secondly, however, firstly, such as, for instance, similarly,
to sum up, in particular, simply, on the other hand

If you release an object held above the floor, it falls to the floor. This is the result of gravity, (1), an invisible attractive forces between the object and the earth. There are two other invisible forces, both capable of repulsion as well as attraction, (2) magnetic and electrostatic forces. The

region in space where one of these forces is effective is called a force field, or (3) a field, as the gravitational field of the earth.

Electrostatic forces exist between objects that carry an electrical charge. (4) a hard rubber rod that is rubbed with fur acquires a "positive" charge. (5), if a glass rod is rubbed with silk, the rod gains a "negative" charge. These charges are like those you develop if you scrape your feet across a rug on a dry day. You can "discharge" yourself by touching another person, each receiving a mild shock in the process.

If a pith ball, a small spongy ball made of plant fiber, is touched with a positively charged rod, the pith ball itself becomes positively charged. When two pith balls that are positively charged are suspended close to each other, they repel each other. (6), two pith balls that have negative charges repel each other. (7), if a positively charged pith ball is placed near a negatively charged pith ball, each one attracts the other. These experiments show that: (8), two objects having the same charge, both positive or both negative, repel each other; (9), two objects having unlike charges, one positive and one negative, attract each other.

(10), electrostatic forces show that matter has electrical properties. These forces are responsible for the energy absorbed or released in chemical changes.

Exercise 14. *Complete the sentences in an appropriate way.*

1. All substances have properties that's why ... 2. Despite the fact that physical properties do not change the chemical nature of matter ... 3. Other physical properties are measured in the laboratory, for instance, ... 4. The melting of ice is a physical change, however, ... 5. A chemical change occurs when the chemical identity of a substance is destroyed and a new substance is formed in contrast to ... 6. Chemical changes can usually be detected by one or more of the five physical senses, in particular, ... 7. To sum up, the more properties a scientist can identify for a substance ...

Exercise 15. *A) Look at the phrases-linkers and decide which of them are used to do the following:*

1) *list / add points;*
2) *introduce examples;*
3) *show contrast;*
4) *introduce a conclusion.*

however	in addition
although	for example

firstly	despite the fact that
such as	in particular
secondly	in contrast
for instance	to sum up
thirdly	on balance
on the one hand	simply
on the other hand	similarly

B) Retell the text using the list of connecting phrases.

UNIT 10
PHYSICAL CLASSIFICATION OF MATTER

Exercise 1. *Learn the following words and word combinations:*

solids - тверді речовини
liquids - рідини
gases - гази
to vibrate - вібрувати
stable, definite shape - стала, визначена форма
volume - об'єм
three dimensions – три виміри
crystalline solid – кристалічне тверде тіло
to distinguish – розрізняти
amorphous solid – аморфне тверде тіло
long-range order – постійний порядок
from a structural standpoint – з точки зору структури
elasticity – еластичність
to be subjected to stress – піддаватися тиску
to be not rigidly fixed – не бути жорстко фіксованим
the process of sublimation – процес сублімації
incompressible fluid – нестислива рідина
attractive and repulsive forces – сили притягання та відштовхування
to be inversely related to – бути обернено пропорційним до
intermolecular attractions – міжмолекулярне тяжіння
to be liquefied by compression – перетворюватися в рідину шляхом стиснення
to exist in equilibrium – існувати в рівновазі

Exercise 2. *Read, translate the text*

Physical Classification of Matter

Based on its physical characteristics, matter is divided into solids, liquids and gases.

Solid

The particles (ions, atoms or molecules) are packed closely together. The forces between particles are strong enough so that the particles cannot move freely but can only vibrate. As a result, a solid has a stable, definite shape, and a definite volume. Solids can only change their shape by force, as when broken or cut.

A solid whose particles are arranged in geometric pattern that repeats itself over and over in three dimensions is a crystalline solid. Each

particle occupies a fixed position in the crystal. It can vibrate about that site but cannot move past its neighbors. In ordinary table salt small cubic crystals of sodium chloride can be distinguished. Large, beautifully formed crystals of such minerals as quartz and fluorite are found in nature.

In an amorphous solid such as glass, rubber, or plastic, there is no long-range order. The pattern does not repeat itself throughout the solid. From a structural standpoint, an amorphous solid is intermediate between the crystalline and the liquid states. In many amorphous solids the particles have some freedom to move with respect to one another. The elasticity of rubber and the tendency of glass to flow when subjected to stress over a long time suggest that the particles in these materials are not rigidly fixed in position.

Solids can be transformed into liquids by melting, and liquids can be transformed into solids by freezing. Solids can also change directly into gases through the process of sublimation.

Liquid

A liquid is a nearly incompressible fluid, which is able to conform to the shape of its container but retains a (nearly) constant volume independent of pressure. The volume is definite if the temperature and pressure are constant. When a solid is heated above its melting point, it becomes liquid, given that the pressure is higher than the triple point of the substance. Intermolecular (or interatomic or interionic) forces are still important, but the molecules have enough energy to move relative to each other and the structure is mobile. This means that the shape of a liquid is not definite but is determined by its container. The volume is usually greater than that of the corresponding solid, the most well-known exception being water, H_20. The highest temperature at which a given liquid can exist is its critical temperature.

The properties of liquids are easily observed and described. Attractive and repulsive forces between the particles are electrostatic in character. These forces are inversely related to the distance between the molecules; the closer the molecules, the stronger the forces. Consequently, the intermolecular attractions in a liquid are strong enough to effect its physical properties.

The properties of liquids are:

1) Liquids cannot be compressed – liquid molecules are “touching close” to each other. There is no space between them, so they cannot be pushed closer;

2) Liquids do not expand – the strong attractions between liquid molecules hold them together at the bottom of a container;

3) Liquids have relatively high densities – the molecules of a liquid are close together, a given number of liquid molecules will occupy a quite small volume;
4) Liquids cannot be mixed in a fixed volume – there is no space between molecules of liquid, so combining liquids must increase volume.

Gas

A gas is a compressible fluid. Not only will a gas conform to the shape of its container but it will also expand to fill the container. In a gas, the molecules have enough kinetic energy so that the affect of intermolecular forces is small (or zero for an ideal gas), and the typical distance between neighboring molecules is much greater than the molecular size. A gas has no definite shape or volume, but occupies the entire container in which it is confined. A liquid may be converted to a gas by heating at constant pressure to the boiling point, or else by reducing the pressure at constant temperature.

At temperatures below its critical temperature, a gas is also called a vapor, and can be liquefied be compression alone without cooling. A vapor can exist in equilibrium with liquid (or solid), in which case the gas pressure equals the vapor pressure of the liquid (or solid).

Some of the familiar characteristics of all gases are the following:
1) Gases may be compressed. A fixed quantity of air may be made to occupy a smaller volume by applying pressure;
2) Gases expand to fill their containers uniformly;
3) All gases have low density. The density of air is 0.0013 g/cm^3. The density of water is 770 times greater than the density of air; and iron is 6000 times denser than air;
4) Gases may be mixed. “There’s always room for move” is a phrase that may be applied to gases. You may add the same or different gas to that gas already occupying a rigid container of fixed volume provided there is no chemical reaction between them;
5) A confined gas exerts constant pressure on the walls of its container uniformly in all directions. This pressure is a unique property of a gas, independent of external factors such as gravitational forces.

The three states of matter are inter-convertible. This is achieved by heating and cooling, which affect the kinetic energy of the particles. Heating increases the kinetic energy of matter: as a result, solids when heated become liquids and liquids become gas, when heated.

Exercise 3. *Answer the questions.*

1. What states is matter divided into according to its physical

characteristics? 2. Are solid particles strong enough so that they can neither move freely nor vibrate? 3. What solid has geometrically arranged particles' pattern that repeats itself over and over in three dimensions? 4. What solid can be called amorphous? Give the examples.5. What solid is considered to be intermediate between the crystalline and the liquid states? 6. How can solids be transformed into liquids and gases? 7. What state of matter is characterized by definite volume under constant temperature and pressure? 8. What molecules have enough energy to move relative to each other? 9. The properties of gases are easily observed and described, aren't they?

Exercise 4. *Say whether the following sentences are true or false.*

1. A solid has a stable, definite shape, but not definite volume. 2. Glass, rubber, or plastic are intermediate between the crystalline and the liquid states. 3. Solids can be transformed into liquids by freezing, and liquids can be transformed into solids by melting. 4. Sublimation is a process of direct changing gases into liquids. 5. The volume of gases is definite if the temperature and pressure are constant. 6. The shape of a liquid is determined by its temperature. 7. The highest temperature at which a given liquid can exist is its limiting temperature.

Exercise *5. Fill the chart below according to the text.*

Property	Solids	Liquids	Gases
Shape and volume			
Compressibility and hardness			
Arrangement of particles			
Diffusion			

Exercise 6. *Choose the right endings to the following sentences.*

1. Because of strong inter-particle forces, solids ...
2. Because of slightly weaker inter-particle forces, liquids …
3. In the absence of any significant inter-molecular forces, …
4. Due to closed-packed structure …
5. Due to more empty space …
6. Because of large empty space between particles …

a) solids are generally hard and incompressible;
b) gases are the most compressible;
c) do not have definite shape but possess definite volume;
d) liquids are more compressible than solids;

e) there is neither a definite shapes or volume in gases;
f) have definite shape and volume.

Exercise 7. *Insert the missing words and word combinations into the text.*

Strong inter-particle attraction, loosely, rigid and geometrical, the whole volume, definite, non-existent, loosely packed, separated, those of solids, container, not definite, mobile

The particles are closely packed and bound by _____, which makes solids _____. This gives them _____ shape and volume, for e.g., rock, wood, steel girders etc. Liquid particles are _____ and are bound to each other with forces weaker than _____. This gives them definite volume but _____ shape. Thus liquids are _____ and take the shape of the _____ in which they are placed. Gas particles are _____ by much greater distances, almost 10 to 100 times the size of the particles. The operating forces of attraction are virtually _____ in gases, resulting in _____ packed particles, which are free to move in any direction. Thus gases possess neither definite volume nor shape and occupy _____ of the vessel in which they are placed e.g., air in ballons, oxygen in cylinders.

Exercise 8. *Put the words in the right order to make a sentence.*

1) consist / particles / at any given / Gases / instant / moving / in straight lines / of molecular.
2) Molecules / with each other / with the container / without / and / loss of energy / collide / walls.
3) molecules / as independent / behave / particles / because / between them / attractive forces / are negligible / Gas.
4) Gas / are / very widely / molecules / spaced.
5) volume / is negligible / of molecules / compared / The actual / to the space / occupy / they.

Exercise 9. *Match the common symbols and abbreviations with their meaning.*

v.	*e.g.*	*No*	*viz.*	*&*
i.e.	≠	*etc.*	=	<
+	≈	→	>	*do*

The same, against (versus), namely, number, and the other things, and, in addition to (plus), greater (more than, better than), smaller (less than), for example, this leads to (causes), is the same as (equals), that is

(this means), is not equal to (opposite), relatively (approximately).

Exercise 10. *Rewrite the sentences using symbols and abbreviations.*

1. Liquids are similar to solids in that the particles touch. 2. Since particles are able to touch, the densities of liquid will be close to that of a solid. 3. An amorphous solid is a solid in which there is no long-range order of the positions of the atoms unlike those in crystalline solids. 4. An example of an amorphous solid is window glass. 5. Since the liquid molecules can move, they will take the shape of their container.

Exercise 11. *Read the text and make short notes using the symbols and abbreviations from Exercise 9.*

Everything on Earth can be explained in terms of 4 states (phases) of matter, namely, solid, liquid, gas, and plasma. A substance in a solid phase is relatively rigid, has a definite volume and shape. It is caused by the fact that the atoms or molecules are packed close together and are not compressible. Because all solids have some thermal energy, its atoms do vibrate. However, this movement is very small and very rapid, this means it cannot be observed under ordinary conditions.

There are four types of crystalline solids. Ionic solids have a definite melting point and contain ionic bonds. An example would be sodium chloride (NaCl). Covalent solids appear as a single giant molecule made up of an almost endless number of covalent bonds. An example would be graphite. Molecular solids are represented as repeating units made up of molecules. An example would be ice. Metallic solids are repeating units made up of metal atoms. The valence electrons in metals are able to jump from atom to atom.

Exercise 12. *Fill in the chart using knowledge you've got from chemistry classes.*

There are gases all around us

Air is a mixture of gases, can you name any of them?	
What gas do we breathe out more than we breathe in?	
Which gas do we need to breathe in to live?	
Can you name any other gases?	

Exercise 13. Translate the sentences into English and put them in the right order to make an instruction to separate two types of solids or a solid and a liquid.

a) Зробіть своє власне сито, пробивши отвори у дні будь-якої консервної бляшанки.
b) Якщо б ви були хорошим садівником чи фермером, чи захотіли б ви усунути каміння з грунту?
c) Спробуйте відділити ці речовини за допомогою звичайного сита.
d) Інколи тверді тіла змішуються з рідинами таким чином, що їх важко відділити за допомогою сита, наприклад, бруд у воді.
e) Або якщо ви перемелюєте пшеницю, щоб отримати зерно, вам потрібно відділити лушпиння від самої муки.
f) Тоді в нагоді стане звичайний фільтр, паперовий або з тканини.
g) Отвори повинні бути достатньо великими, щоб дозволити найменшій твердій речовині просипатися через них, але достатньо малими, щоб затримати більші частинки.

Exercise 14. *Describe different matter using suggested words and word combinations.*

The wood block	Solid, a certain, size and shape, not to change, examples, computer, the desk, and the floor, by sawing or burning.

Milk	Liquid, a size or volume, to take up space, a definite shape, container, to flow, to be poured, to go everywhere, to wipe it up, the shape of the floor, expansive limitless boundary.
Jello, peanut butter	To spread on bread, not to flow, not a liquid, at room temperature, to heat up, a liquid, to put it in refrigerator, to become a solid, yummy forms of matter, with properties of a liquid and a solid.
Oxygen	To live, to hold the breath, can't see, invisible, a gas, to have no shape or size of its own, no color, all around you, to feel, the wind blow, moving air, to mix together.

Exercise 15. *Read the text and compare two additional states of matter. The points for comparison can be:*

a) *atoms and molecules;*
b) *sphere of existence;*
c) *examples;*
d) *inter-particle collision.*

What are the Fourth and the Fifth States of Matter?

The fourth state of matter is plasma. Plasma is an ionized gas, a gas into which sufficient energy is provided to free electrons from atoms or molecules and to allow both species, ions and electrons, to coexist. In effect a plasma is a cloud of protons, neutrons and electrons where all the electrons have come loose from their respective molecules and atoms, giving the plasma the ability to act as a whole rather than as a bunch of atoms. Plasmas are the most common state of matter in the universe comprising more than 99% of our visible universe and most of that not visible.

Plasma occurs naturally and makes up the stuff of our sun, the core of stars and occurs in quasars, x-ray beam emitting pulsars, and supernovas. On earth, plasma is naturally occurring in flames, lightning and the auroras. Most space plasmas have a very low density, for example the Solar Wind which averages only 10 particles per cubic-cm. Inter-particle collisions are unlikely - hence these plasmas are termed collisionless.

The collapse of the atoms into a single quantum state is known as Bose condensation or Bose-Einstein condensation is now considered a 5th state of matter.

Recently, scientists have discovered the Bose-Einstein condensate, which can be thought of as the opposite of plasma. It occurs at ultra-low temperature, close to the point that the atoms are not moving at all. A Bose- Einstein condensate is a gaseous superfluid phase formed by atoms cooled to temperatures very near to absolute zero. The first such condensate was produced by Eric Cornell and Carl Wieman in 1995 at the University of Colorado at Boulder, using a gas of rubidium atoms cooled to 170 nanokelvins (nK). Under such conditions, a large fraction of the atoms collapse into the lowest quantum state, producing a superfluid. This phenomenon was predicted in the 1920s by Satyendra Nath Bose and Albert Einstein, based on Bose's work on the statistical mechanics of photons, which was then formalized and generalized by Einstein.

Exercise 16. *Find a partner and make a list of different physical states of matter and their properties. Work with another team and read the chosen properties in any order you like for them to guess what states of matter you are describing.*

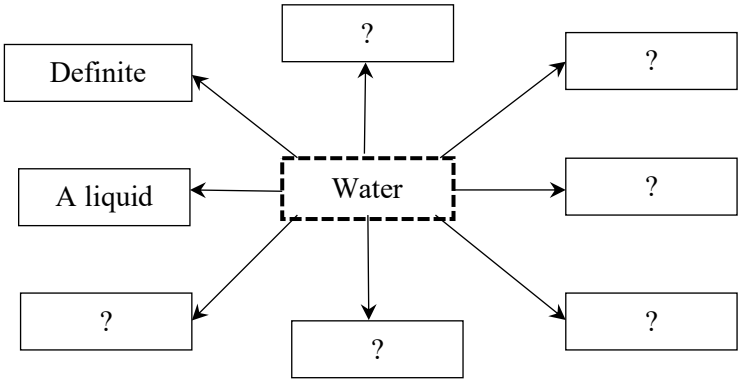
e.g. 1) It has a definite volume, but is able to change its shape by flowing. 2) Its particles are able to move around and take the shape of their container. (We are talking about a liquid).

Exercise 17. *Translate the text into English in written form.*

Аморфні тверді тіла

Аморфні тверді тіла не мають визначеної точки танення чи регулярно повторюваних одиниць. Аморфне тверде тіло – це тверде тіло, в якому не існує довготривалого порядку позицій атомів, який притаманний кристалічним твердим тілам. Прикладом аморфного твердого тіла може бути віконне скло. Крім того багато полімерів таких як полістерин, є аморфними. Аморфні тверді тіла можуть існувати у двох чітко визначених станах, «гумовому» та «скляному» станах. Температура, при якій вони переходять від скляного до гумового стану, називається їх температурою переходу скла (Tg).

Exercise 18. *Before text reading make a little map of your knowledge about such liquid as water. Then read the text and check whether you are right. E.g.:*



“Unusual” Compound

Sometimes a substance does not behave it is expected to, but the most substances fit into regular patterns. Water does not fit. Water is so common, so much a part of our daily lives, that it is hard to think of it as being unusual.

A close examination of the water molecule gives some clues to explain this unique behavior. Aside from fluorine, oxygen is the most electronegative element there is. Therefore, the electrons forming each bond between hydrogen and oxygen are drawn strongly toward the oxygen atom, resulting in two very polar bonds - more polar than the bonds in other hydrides in the group. Finally, hydrogen bonding is probably most important contributor to strong intermolecular attractions in water.

Among molecules of comparable size, water has several other unusual properties. Exceptionally high surface tension and heats of vaporization and fusion are among them. Its vapor pressure is particularly low, even compared to larger molecules whose vapor pressures are expected to be low.

Water is viscous when compared to substances with similar structures. Water dissolves wider variety gaseous, liquid, and solid substances than most solvents. Finally, the mere fact that water is a liquid at room conditions unusual. Water is one of a very small number of inorganic compounds that exist as liquids at normal temperatures and pressures.

Water's most visible unusual property is that its solid form, ice, floats on its liquid form. Almost all substances expand - become less dense - when heated; and they contract - become denser - when cooled. Water also becomes denser as it is cooled - until it reaches 4°C. Below 4°C, it turns around and becomes less dense. When water freezes, there is about a *9%* increase in volume as the molecules arrange themselves into an "open"

crystal structure compared to the closer packing they have as a liquid. This expansion exerts enough force to break water pipes if the liquid is permitted to freeze in them.

Water is a most unusual compound. Much of life on earth could not exist but for molecular structure and the unique properties it produces.

Exercise 19. *Work in pairs and make up dialogues discussing five types of matter. The conversation may be:*

a) between a teacher and a student;
b) between two students after a lecture;
c) between Albert Einstein and a modem time traveler;
d) between a housewife and a well-known researcher;
e) your own variant.

Exercise 20. *Match the specific properties of liquid with their explanations.*

Viscosity, Surface Tension, Vapor Pressure, Boiling Point

— The pressure that a solid or liquid exerts when it is in equilibrium with its vapor at a given temperature;
— When vapor pressure is equal to atmospheric pressure;
— The result of attraction between molecules of a liquid which causes the surface of the liquid to act as a thin elastic film under tension. It causes water to form spherical drops;
—The resistance of a liquid to flow.

Exercise 21. *Check your understanding of the material of the lesson.*

1. When ice melts, ...

a) a phase change occurs from a solid phase to liquid phase
b) an endothermic process occurs which requires energy
c) the water changes from a crystalline solid to a liquid
d) all of the above

2. When water freezes, ...

a) a phase change occurs from a liquid phase to a solid phase
b) an exothermic process occurs where energy is lost from ice to the surroundings
c) the liquid water changes from a random structure to a crystalline solid
d) all of the above

3. The Bose-Einstein phase of matter occurs closest to what temperature?

a) boiling point of water

b) freezing point of water
c) absolute zero
d) 10,000 degrees F.

4. Which statement is not true.

a) to change from a solid to a liquid requires energy
b) depending upon the temperature, water can exist in solid, liquid or states
c) solids and liquids have similar densities because particles of solids liquids both touch
d) in a solid the molecules have no motion, and no energy.

5. Lightning is best classified as:

a) plasma
b) liquid
c) gas

UNIT 11
CHEMICAL REACTIONS AND EQUATIONS

Exercise 1. *Learn the following words and word combinations:*
to interact - взаємодіяти
to occur - траплятися
to come in close contact with - взаємодіяти, контактувати
to be exposed to - піддавати (чомусь)
constituents of the reaction - складові реакції
to involve the making or breaking of chemical bonds - спричиняти утворення або руйнування хімічних зв'язків
oxidation - окиснення
reduction - відновлення
dissociation - розпад
acid-base neutralization - кислотно-лужна нейтралізація
molecular rearrangement - заміщення
to combine with - сполучатися
to be symbolically depicted - бути символічно зображеним
the sequence of steps - послідовність кроків (етапів)
reactant (starting material) - реагент (початковий матеріал)
product (resulting substance) - продукт (вихідна речовина)
to balance a chemical equation - зрівноважувати рівняння
to establish the relationship - встановлювати взаємозв'язки
to put an arrow - розміщати стрілку
to place coefficient - розставляти коефіцієнти
to add subscripts - додавати індекси
to indicate the states of matter - вказувати стан матерії
rate of the reaction - швидкість реакції
pressure - тиск
to be accompanied by a change - супроводжуватися зміною
invariably - незмінно, стало
exothermic reaction - екзотермічна реакція
endothermic reaction - ендотермічна реакція
to absorb heat - поглинати тепло
to release heat - виділяти тепло
to undergo a transformation - зазнавати перетворення

Exercise 2. *Read and translate the text. Make short notes about the nature of* the *chemical reactions, their types, factors they depend on,*

chemical equations and the steps to balance them.

Chemical Reactions

Chemical reactions are part of our daily lives from cooking in the kitchen, to driving a car. Reaction happens when two or more molecules interact and a chemical change occurs. When a chemical substance is transformed as a result of its interaction with another or energy, a chemical reaction is said to have occurred. Chemical reaction takes place when a substance comes in close contact with another substance, a mixture, a solution, or is exposed to some form of energy. It results in some energy exchange between the constituents of the reaction. Chemical reactions usually involve the making or breaking of chemical bonds. Oxidation, reduction, dissociation, acid-base neutralization and molecular rearrangement are some of the commonly used kinds of chemical reactions.

For example, a steel garbage can rusting is a chemical reaction. The rusting happens because the iron (Fe) in the metal combines with oxygen (O_2) in the atmosphere.

A chemical reaction can be symbolically depicted through a chemical equation. The sequence of steps taking place in the course of a chemical reaction is called its mechanism. Many physical chemists specialize in exploring and proposing the mechanisms of various chemical reactions.

A chemical equation describes what happens in a chemical reaction. The equation identifies the reactants (starting materials) and products (resulting substance), the formulas of the participants, the phases of the participants (solid, liquid, gas), and the amount of each substance. Balancing a chemical equation refers to establishing the mathematical relationship between the quantity of reactants and products. There are essentially three steps to the process:

1) write the chemical formulas of reactants on the left side of the equation and products - on the right;
2) put an arrow between them to show the direction of the reaction;
3) balance chemical formulas by placing coefficients in front of them, do not add subscripts, because this will change the formulas;
4) indicate the states of matter of the reactants and products. Use (g) for gaseous substances, (s) for solids, (l) for liquids, (aq) for species in solution in water.

The speed at which a reaction happens is called the rate of the reaction. If a reaction has a low rate, that means the molecules combine at a slower speed than a reaction with a high rate. The rate of reaction depends on the type of molecules, concentration of substance, temperature at which

the reaction takes place. Pressure can also affect the rate of reaction. The lower pressure decreases the rate of reaction.

Since a chemical transformation is accompanied by a change in structure, it is invariably accompanied by an increase or decrease of energy of the substances (in the form of heat or light). A reaction is said to be exothermic if the reaction releases heat to the surroundings; in the case of endothermic reactions, the reaction absorbs heat from the surroundings.

The term chemical energy is often used to indicate the potential of a chemical substance to undergo a transformation through a chemical reaction or to transform other chemical substances.

Exercise 3. *Answer the following questions to the text.*

1. When does a chemical reaction happen? 2. What happens when a substance comes in close contact with another substance? 3. What does chemical reaction result in? 4. What kinds of chemical reactions are commonly used? 5. How would you symbolically depict chemical reaction?
6. What is called a reaction mechanism? 7. What does the equation identify? 8. What steps are essential to transform chemical reaction into chemical equation? 9. What is called the rate of the reaction? 10. What does the rate of reaction depend on? 11. What reaction is considered to be exothermic? 12. What reaction is called endothermic reaction?

Exercise 4. *Write out from the text all the verbs which play the role of predicates and complete the chart.*

Verbs in Active Form	Verbs in Passive Form	Initial Form
1. are	-	to be
2. -	is transformed	to be transformed

Exercise 5. *Identify one underlined word that must be changed to make the sentence correct.*

1. When a chemical substance is transformed, a chemical equation is said to have occurred. 2. Chemical reactions usually involve the destroying or breaking of chemical bonds. 3. The consequence of steps taking place in the course of a chemical reaction is called its mechanism. 4. A chemical equation describes what happens in a chemical mechanism. 5. To balance chemical reactions one should place coefficients behind them and do not add subscripts. 6. A reaction is said to be endothermic if the reaction releases heat to the surroundings.

Exercise 6. *Match the chemical laws with their explanations. Translate them into Ukrainian.*

A chemical reaction is a transformation of some substances into one or more other substances. Chemical reaction 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 and the energy changes that may accompany it are defined by certain basic rules, known as *chemical laws,* which have become fundamental concepts in chemistry.

Chemical laws:

1. Henry's law;
2. Law of conservation of mass;
3. Law of mass action;
4. Law of multiple proportions;
5. Mendeleev's law, periodic law;
6. Law of definite proportions;
7. Law of equivalent proportions, law of reciprocal proportions.

Meanings:

a) it is actually energy that is conserved, and that energy and mass are related; a concept which becomes important in nuclear chemistry.

b) law stating that when two elements can combine to form more than one compound the amounts of one of them that combines with a fixed amount of the other will exhibit a simple multiple relation.

c) the law that states the following principle: the rate of a chemical reaction is directly proportional to the molecular concentrations of the reacting substances.

d) the principle that chemical properties of the elements are periodic functions of their atomic numbers.

e) law stating that the proportions in which two elements separately combine with a third element are also the proportions in which they combine together.

f) law stating that every pure substance always contains the same elements combined in the same proportions by weight.

g) law formulated by the English chemist William Henry; the amount of a gas that will be absorbed by water increases as the gas pressure increases.

Exercise 7. *Find the definitions to the following terms. Memorize the definitions.*

atomic mass (atomic weight), molecular weight, negativity, valence

a) the tendency of an atom or radical to attract electrons in the formation of an ionic bond;

b) the mass of an atom of a chemical element expressed in atomic mass units;

c) the sum of the relative atomic masses of the constituent atoms of a molecule;

d) a property of atoms or radicals; their combining power given in terms of the number of hydrogen atoms (or the equivalent).

Exercise 8. *Divide given chemical terms into the following themes: chemical reaction, atomic theory, periodic law. State what terms can be applied to more than one theme.*

Acid, alkali, alkali metal, alkaline earth metal, atom, atomic mass, atomic number, base, chain reaction, combustion, compound, concentrated, condensation, dilute, distillation, electron, element, equation, evaporation, fatty acid, formula, halogen, lanthanide or rare-earth element, metal, mole, molecule, neutron, noble gas or inert gas, nonmetal, nucleus, periodic table, proton, reagent.

Exercise 9. *Read the rules of formulas and equations reading and memorize them.*

Rules of the Formulas and Equations Reading

The letters of the Latin alphabet meaning titles of elements are read as the English titles of letters of the alphabet: C [si:], Ca [si: ei], Ag [ei: dzi:]. A digit before a label of an element specifies number of molecules and is read as follows: $2H_20$ [tu: 'molikju:lz av 'eitch 'tu: 'ou], 4HC1 [fo: 'molikju:lz av 'eitch 'si 'el], CH_4 [si: eitch fo:].

The signs of equations of chemical reactions can be read as follows:

$\rightarrow$	Give, pass over to, lead to, forms, is formed from
=	Give or form
+	Plus, together with

Example: $4HC1 + 0_2 = 2C1_2 + 2H_20$

[To: 'molikjulz av 'eitch 'si 'el plus ou tu: giv tu: 'molikju:lz av 'si 'el tu: end tu: 'molikju:lz ev 'eitch 'tu: 'ou].

The sign $\rightarrow$ means "yields" and shows the direction of the action. A small delta (D) above the arrow shows that heat has been added. A

double arrow ↔ shows that the reaction is reversible and can go in both directions.

Exercise 10. *Read the following reactions.*

$$NaOH + HC1 = NaCl + H_20;$$
$$BaCl_2 + Na_2S0_4 = BaS0_4 + 2NaCl;$$
$$NaCl + AgN0_3 \rightarrow NaN0_3 + AgCl;$$
$$C_{10}H_8 + 120_2 \rightarrow 10CO_2 + 4H_20.$$

Exercise 11. *Transform the verbal descriptions of the following reactions with the help of chemical equations.*

1. Potassium Chlorate is a compound containing potassium, chlorine and oxygen. It is often used as a disinfectant and in fireworks and explosives. When potassium chlorate is heated to melting point, any item added to it will cause a rapid disintegration in the form of an explosion. The gas coming off the potassium chlorate is oxygen. It is often used in airplanes, space stations, submarines as a source of oxygen.

2. Sodium is a highly combustible element and the addition of water can make it explode. A drop of water added to a small piece of sodium in a flask filled with chlorine gas. The distinctive yellow color of the light emitted is often used in street lighting. This experiment produces a great deal of heat. When you combine sodium and chlorine, you get sodium chloride - common salt.

Exercise 12. *Read and translate the questions, each of them contain a mistake. Correct the mistakes and answer the questions.*

1. What are a chemical reaction? 2. What types can all chemical reactions classified into? 3. What is reaction called exothermic? 4. How is a chemical change? 5. What reaction we call endothermic? 6. How we usually describe the rate of a reaction? 7. Where did the energy come from?

Exercise 13. *Open the brackets and translate the words and word combinations into English.*

Temperature

Usually, an (підвищення) in temperature (супроводжується) by an increase in the (швидкості реакції). Temperature is a (міра кінетичної енергії) of a system, so higher temperature (призводить до) higher average kinetic energy of molecules and (більшої кількості зіткнень) per unit time. A (загальне правило) of thumb for most (not all) chemical reactions is that the (швидкість) at which the reaction proceeds

(приблизна подвоїться) for each 10°C increase in temperature. Once the temperature (досягає певної точки), some of the chemical species may (бути змінені) (e.g., denaturing of proteins) and the chemical reaction (уповільниться або зупиниться).

Exercise 14. *Match the names of the reactions with their descriptions.*

Photochemical, Equilibrium, Double Replacement, Decomposition, Combustion, Combination

1) It begins with two or more substances and when the reaction is complete form a single product substance;
2) This reaction produces light and heat as energy products in addition to new chemical substances;
3) It begins with a single substance and forms two or more new product substances;
4) They are reactions in which the elements or ions of both reactants change partners to form two new products;
5) It is a chemical reaction in which all reactants and products are present simultaneously;
6) It relies on light energy for chemical transformations to occur.

Exercise 15. *Make up sentences putting the words in the correct order.*

1) In order to write/ we must balance/ a correct chemical equation,/ on the left side/ of the reaction/ all of the atoms/ with the atoms/ on the right side.
2) of matter/ The law of conservation/ states that/ lost nor gained/ matter is neither/ reactions/ in traditional chemical.
3) at equilibrium/ not static/ A system of/ even though having/ chemical substances/ an unchanging composition/ is often.
4) are not/ present in/ Chemicals/ biological systems/ at equilibrium.
5) Because the mole/ a standard number/ refers to/ of atoms/ the term/ substituted into/ can simply be/ chemical equations.

Exercise 16. *Translate the text into English.*

Хімічні зміни також називають хімічними реакціями. Хімічні реакції включають поєднання різних речовин. У результаті реакції виникає нова речовина з різними фізичними і хімічними властивостями. Матерія не з'являється і не руйнується в процесі хімічної реакції: частинки однієї речовини лише переміщаються, щоб утворити нову речовину. Проте така сама їх кількість, яка існувала до реакції, продовжує існувати і після хімічної реакції. Інша ознака

хімічної реакції - це енергія, що виділяється або поглинається нею. Багато речовин поглинають енергію для того, щоб зазнати хімічної зміни, наприклад, випікання хліба тощо.

Exercise 17. *Check whether you are a real scientist.*

A) Are these sentences true or false?

1. Reactions start with products and create reactants.
   a) True; b) False.
2. All elements can bond with all other elements.
   a) True; b) False.
3. During reactions both the molecules and states of matter can change.
   a) True; b) False.
4. Reactions always require energy to occur.
   a) True; b) False.
5. All chemical reactions happen at the same speed.
   a) True; b) False.
6. Reaction rate can be changed.
   a) True; b) False.

B) Complete the sentences with the following options.

1. Chemical reactions create and break down ...
   a) proton orbitals;
   b) chemical bonds;
   c) atomic nuclei.
2. Reaction rates can be changed by changes in ...
   a) concentration;
   b) temperature;
   c) pressure.
3. Catalysts ... reaction.
   a) speed up;
   b) slow down;
   c) neither speed up nor slow down.
4. Reaction rate can be defined as ...
   a) change in concentration over a period of time;
   b) change in equilibrium over a period of time;
   c) The speed at which the reaction happens.
5. The reaction rate at equilibrium would be ...
   a) zero;
   b) minus one;
   c) plus one.

UNIT 12
RADIATION AND NUCLEAR CHEMISTRY

Exercise 1. *Learn the following words and word combinations:*
nuclear process - атомний процес
to associate with - стосуватися, мати відношення
equipment - обладнання
absorption of radiation - поглинання радіації
radioactive source - джерело радіації
medical application - медичне застосування
tracer - мічений атом
environment - навколишнє середовище
to modify material - видозмінювати речовину
atomic nucleus - атомне ядро
to bind - зв'язувати, створювати
source of energy - джерело енергії
fusion - синтез, злиття
to split - розщеплювати, розпадатися
fission - розщеплення, розпад
to supply energy - постачати енергію
to consume - споживати
break-up - розпад
chain reaction - ланцюгова реакція
nuclear weapon - атомна зброя
to convert - перетворювати
devastating effect - руйнівний ефект
unlimited amounts of electricity - необмежена кількість електроенергії
supply of fossil fuel - запаси викопного палива
green house effect - парниковий ефект
capital investment - капіталовкладення
nuclear power station - атомна електростанція
accidental leak of radiation - випадковий витік радіації
disposal of radiation waste - ліквідація радіоактивних відходів

Exercise 2. *Read and translate the text. Make short notes about the nature of the nuclear reactions, their types and factors they depend on.*

Radiation and Nuclear Chemistry

Nuclear chemistry is the subfield of chemistry dealing with radioactivity, nuclear processes and nuclear properties. It is the chemistry of radioactive elements together with the chemistry associated with

equipment designed to perform nuclear processes. It includes the study of the chemical effects resulting from the absorption of radiation within living animals, plants, and other materials; the study of the production and use of radioactive sources; radiotherapy in medical applications; the use of radioactive tracers within industry, science and the environment; and the use of radiation to modify materials such as polymers, etc.

The protons and the neutrons in atomic nuclei are bound together with forces that are much greater than the forces that bind atoms together to form molecules. In fact, the energies associated with nuclear processes are more than a million times those associated with chemical reactions. This potentially makes the nucleus a very attractive source of energy. There are two types of nuclear process that produce energy: 1) combining two light nuclei to form a heavier nucleus (fusion); 2) splitting a heavy nucleus into two nuclei with smaller mass numbers (fission). These processes can supply amazing quantities of energy with relatively small masses of materials consumed.

Nuclear fission was discovered in the late 1930 when U-nuclides bombarded with neutrons were observed to split into two lighter elements. Neutrons released from the break-up of one nucleus bombard other nuclei, causing a chain reaction which leads to sudden, explosive release of energy. This is the basis of both nuclear weapons and nuclear power, in which energy of nuclear fission is converted to electricity. During World War II, the United States carried out an intense research effort called the Manhattan Project to build a bomb on the principles of nuclear fission. This program produced the fission bomb, which was used with devastating effect on the cities of Hiroshima and Nagasaki in 1945.

The process of combining two light nuclei, called nuclear fusion, produces even more energy per mole then does nuclear fission. In fact, stars produce their energy through nuclear fusion. Our sun, which presently consists of 73% hydrogen, 26% helium and 1% other elements, gives off vast quantities of energy from the fusion of protons to form helium. In nuclear fusion, two nuclei join together: the protons and the neutrons combine to form a larger nucleus, some protons, neutrons and other particles escape, and energy is released. Because of the tremendous energy involved, fission has been developed as an energy source to produce electricity in reactors where controlled fission can occur.

Only few decades ago nuclear energy was thought to be a clean, modem and efficient way to generate almost unlimited amounts of electricity. There are several arguments for using nuclear power: the supply of fossil fuels is limited; burning fossil fuels is harmful to the

environment adding to the green house effect; the earth contains a large supply of natural uranium; nuclear power comes to the consumer as electricity, which is a clear and convenient form of energy; although the capital investment is high, the cost of generating electricity from established nuclear power station is relatively low.

However, there are many serious reasons against using nuclear power. First, there is the danger of nuclear war. The wide spread use of nuclear energy and the development of new technology increase the risk of nuclear weapons. Plutonium is one of the most dangerous substances that man uses. A society based on nuclear energy is facing the problems of terrorist activity and pollution. Even 'peaceful' nuclear power is a danger to health. Nuclear power stations are a potential source of harmful radiation. Accidental leaks of radiation occur. But even if all goes well, power stations have to deal with the disposal of radiation wastes from nuclear reactors. The potential threats of cancer and genetic mutations make these materials especially frightening.

Exercise 3. *Answer the following questions to the text.*

1. What is a nuclear chemistry? 2. How do the forces that hold an atomic nucleus together compare in strength with forces between atoms in a molecule? 3. How do the energies released by nuclear processes compare in magnitude with the energies of ordinary chemical processes? 4. What makes the nucleus a very attractive source of energy? 5. What are two types of nuclear processes that produce energy? 6. Which process results the production of a heavier nucleus? 7. Which process results in the production of smaller nuclei? 8. What is needed for a chain reaction to take place? 9. What principle does a nuclear reactor depend on for its operation? 10. What type of nuclear reaction takes place in stars? 11. What threats are caused by the radioactive waste?

Exercise 4. *In the paragraph indicated by the number in parenthesis, find the word or phrase that best fits the meaning given.*

1. connected with (1)
2. to divide into (2)
3. absorbed (2)
4. results in (3)
5. lead to (3)
6. transformed (3)
5. a sudden violent burst of energy (3)
7. produces (energy) (4)

8. take place (4)
9. central or most important part of anything (4)
10. discussion, disagreement over the matters of public (5)
11. something that is no longer of use or cannot be used (6)
12. anything that may harm you (6)

Exercise 5. *Give a definition, synonym or description of each of the words or phrases below. Compose your own sentences with them.*

In fact, amazing quantities, self-sustained process, on the average, fissionable material, fusion, vast, malfunction, safety systems, to question the wisdom, efficiency, handling, harmful radiation, genetic mutations, accidental leaks, especially frightening, to be sealed in concrete or glass blocks, weathering.

Exercise 6. *Select or write the sentences that best express the main idea of each paragraph of the text. Make the plan of the text.*

Exercise 7. *Find the definitions to the following terms. Memorize the definitions.*

nucleus, fusion, fission, neutron, explosion, malfunction, nuclear waste, radiation

A) Radioactive waste material, for example from the use or reprocessing of nuclear fuel;
B) The emission of energy as electromagnetic waves or as moving subatomic particles, especially high-energy particles which cause ionization;
C) A failure to function normally;
D) A subatomic particle of about the same mass as a proton but without an electric charge, present in all atomic nuclei except those of ordinary hydrogen;
E) A violent shattering or blowing apart of something, as is caused by a bomb;
F) Division or splitting into two or more parts;
G) The central and most important part of an object, movement, or group, forming the basis for its activity and growth;
H) The process or result of joining two or more things together to form a single entity.

Exercise 8. *Select the statements that best expresses the main ideas of the text.*

1. Nuclear power may be produced in the course of a chain reaction.
2. There are two types of nuclear processes that produced energy: fission and fusion.
3. The energies released by nuclear processes are more than a million times those associated with chemical reactions.
4. A chain reaction, which leads to a release of energy, is the basis of both nuclear weapons and nuclear power.
5. Nuclear fission is the process in which nuclides of certain heavy metals can be split into lighter elements with a release of great amounts of energy: nuclear weapons and nuclear power work on the principles of nuclear fission.
6. Stars produce their energy through nuclear fission.
7. A thermonuclear bomb works on the principle of nuclear fusion.
8. Fission based power plants are used to heat water to produce steam that runs turbine generators, in much the some way that a coal-burning power generates energy.
9. A great deal of controversy now exists about the efficiency of the safety systems in power plants.
10. There are different types of fission-based power plants provided with the safety systems, but accidents occur, and much controversy surrounds the use of nuclear energy to generate electricity.

Exercise 9. *Choose one word from the box for each group of the words. Use the words only once.*

research	event	intensity	nuclear	escalate
material	reaction	critical	systems	safety

1. chain...
   nuclear...
   chemical...
2. incredible...
   low...
   high...
3. ... mass
   ... question
   ... state
4. ... bomb
   ... power
   ... reactor
5. fissionable...
   man-made...
   natural...
6. ... the process
   ... the negative consequences
   ... the pollution
7. fission...
   current...
8. intense…
   promising...

historic...	fundamental...
9. ... precautions	10. high-level...
... systems	background...
...zone	...pollution

Exercise 10. *Place the appropriate word from the list in each of the blanks below. Do not use word more than once.*

generations, harmful, threat, fusion, fission, break up, chain, fissionable, released

1. Uranium-235 undergoes ... by the absorption of slow neutrons. 2. There are two types of nuclear reaction: fission and ... . 3. Natural radioactive decay does not normally release much energy because the nuclei ... very slowly, sometimes over hundreds of years. 4. A nuclear ... reaction can result if neutrons from each fission cause more nuclei to split. 5. A critical mass of a ... material is the amount needed to provide a high enough internal neutrons flux to sustain the chain reaction. 6. Nuclear power stations are a potential source of ... radiation. 7. The radiation ... when atoms split causes cancer and birth defects. 8. Genetic damage is damage to the genetic machinery of the organism, which will be manifested in future ... . 9. The use of nuclear fuels could lead to pollution of the environment or a dangerous terrorist....

Exercise 11. *Complete the sentences using the knowledge of other disciplines.*

1. A major problem that the atomic energy authority has to deal with is ... .2. There are two approaches to the nuclear waste .... 3. The problems of handling and storing highly radioactive waste can ... . 4. Over long period, materials such as glass or concrete may ... . 5. Some low-activity waste is sealed in .... 6. The problem of the nuclear waste still remains .... 7. The use of nuclear fuel could lead to pollution ....

Exercise 12. *Put the sentences in the right order to make the text.*

(1) When Becquerel discovered that, with no external source of energy, the uranium generated rays, which could blacken the photographic plate, radioactivity was discovered.

(2) Marie Curie and her husband Pierre Curie isolated two new radioactive elements from uranium ore.

(3) After the discovery of X-rays by Wilhelm Röntgen, many scientists began to work on ionizing radiation.

(4) They separated the uranium ore into each of the different chemical

elements that were known at the time, and measured the radioactivity of each fraction.
(5) One of these was Henri Becquerel, who investigated the relationship between phosphorescence and the blackening of photographic plates.
(6) They used radiometric methods to identify which stream the radioactivity was in after each chemical separation.
(7) They then attempted to separate these radioactive fractions further, to isolate a smaller fraction with a higher specific activity.
(8) In this way, they isolated polonium and radium.

Exercise 13. *Open the brackets and put the verbs into correct grammar form.*

Early History of Radiation

It (to notice) in about 1901 that high doses of radiation (can/ to cause) an injury in humans. Henri Becquerel (to carry) **a** sample of radium in his pocket and as a result he (to suffer) **a** high localized dose which (to result) in a radiation bum. This injury (to result) in the biological properties of radiation being investigated, which in time (to result) in the development of medical treatments.

Ernest Rutherford, working in Canada and England, (to show) that radioactivity decay (can/ to describe) by a simple equation, implying that a given radioactive substance (to have) a characteristic "half-life". He also (to coin) the terms alpha, beta and gamma rays, he (to convert) nitrogen into oxygen, and most importantly he (to supervise) the students who (to do) the Geiger-Marsden experiment which (to show) that the 'plum pudding model' of the atom (to be) wrong. To Rutherford, the gold foil experiment (to imply) that the positive charge (to confine) to a very small nucleus leading first to the Rutherford model, and eventually to the Bohr model of the atom, where the positive nucleus (to surround) by the negative electrons.

Exercise 14. *Translate the text into English.*

Радіаційна хімія - розділ хімії високих енергій, що у свою чергу є розділом фізичної хімії. Термін вперше введений в 1945 році М. Бертом. Радіаційна хімія описує хімічні процеси, що викликаються іонізуючим випромінюванням на речовину. Випромінювання, що бере участь у реакціях має енергію збудження чи кінетичну енергію, що часто перевищую не тільки теплову енергію, але й енергію хімічного зв'язку. Атомна енергія - це енергія, одержувана з атома. Кожний атом складається із часточок енергії. Ця

енергія поєднує всі частки атома разом. Тому в атомній енергії ядро атома є джерелом енергії. Ця енергія виділяється при розщепленні атома. Існує два способи одержання енергії з атома. Перший - це реакція синтезу, другий - реакція розподілу. При реакції синтезу два атоми зливаються разом і утворять єдиний атом. При сполуці атомів виділяється величезна енергія у вигляді тепла. Другий спосіб - це реакція розподілу, або розщеплення. Розщеплення відбувається при розподілі одного атома на два.

Exercise 15. *Read and translate the text. Put 7 special questions to the text. Check whether your knowledge is enough to protect yourself during radiation emergency.*

Basic Steps to Protect Yourself and Your Family in a Radiation Emergency

If a radiation emergency occurs, people can take actions to protect themselves, their loved ones, and their pets. Emergency workers and local officials are trained to respond to disaster situations and will provide specific actions to help keep people safe.

If a radiation emergency happens near where people live or work, you can take immediate action to protect yourself, your loved ones, and others around you. This kind of emergency could be a dirty bomb or nuclear explosion, a nuclear power plant accident, or a transportation accident. These actions will protect people in a radiation emergency:

Get inside and stay inside an undamaged building.

If possible, shower and change into clean clothes.

Stay tuned to television or radio for updates and instructions.

Emergency workers and local officials are trained to respond to different types of situations and will give you specific instructions to keep you safe.

The term “population monitoring” is a process of immediate monitoring after an incident and long-term monitoring for health effects from the event.

Within the first hours and days after a radiological incident, people should be monitored with special equipment that is designed to detect radiation. Public health officials will use the information from the monitoring equipment to find out whether people are contaminated, either inside their bodies (internal) or outside their bodies (external), with radioactive materials from the incident or attack. Public health officials also will estimate the amount of radiation to which people were exposed, also known as the dose, through a process called dose assessment.

In addition, the health of people who were involved in the incident will be monitored over many years to see whether people are having health effects from the emergency. These health effects could include effects related to radiation exposure or effects associated with the stress of being involved in an incident. This is known as a health registry.

Exercise 16. *Complete the list of instructions that will protect people in a radiation emergency:*

1) Get inside and stay inside an undamaged building;
2) If possible, shower and change into clean clothes;
3) Stay tuned to television or radio for updates and instructions;
4) ...
5) ...

Exercise 17. *Work in small groups and discuss the following questions.*

- What are the advantages and disadvantages of nuclear power?
- Why do some countries remain nuclear-free?
- Is it true that nuclear reactors supply about 15% of all electricity generated in the world?
- What accident has led many people to question the wisdom of continuing to build and make use of nuclear power plants?
- What do you know about consequences of Chernobyl accident in 1986?
- What tragedy happened in Japan in 2011?
- What lesson, if any, has been extracted from the tragic event?

UNIT 13
OIL AND ITS ORIGIN

Exercise 1. *Learn the following words and word combinations:*

hydrocarbons - вуглеводні
greasy burning liquid - маслянiста горюча рідина
dilutable - розчинний
molecular mass - молекулярна маса
rigid and gaseous hydrocarbons - тверді та газоподібні вуглеводні
to alternate - змінюватися, чергуватися
individual substance - окрема речовина
wide interval of temperatures - широкий інтервал температур
to outrun - переганяти, піддавати перегонці
moderate heating - помірне нагрівання
fossil fuel - викопне паливо
silt - мул, осад на дні
mud - бруд
energy source - джерело енергії
oil producing region - район видобування нафти
crude oil - сира, неочищена нафта
arguably - суперечливо
the second most influential - другий за впливом (важливістю)
oil well - нафтова свердловина
exponentially - експонанціально, за показниками
natural seepage - природні поклади, витоки
subsurface oil - поверхнева нафта
limited availability - обмежена доступність
petroleum - нафта (інколи бензин)
sufficient quantity - достатня кількість
larger-scale processing system - масштабна переробна система
alkanes - алкани
cyclo-alkanes - цикло-алкани
aroma hydrocarbons - ароматичні вуглеводні
pitch — смола, дьоготь
fraction - фракція
fellow-traveled gas - супутній газ
via outrunning - шляхом перегонки

Exercise 2. *Read and translate the text.*

Oil and its Origin

Oil is one of the important natural sources of hydrocarbons. Oil is a greasy burning liquid that has dark-brown or almost black color with characteristic smell. It is lighter than water, practically not dilutable in it. Due to the structure oil is the mixture of hydrocarbons of different molecular mass, mainly liquid, in which the rigid and gaseous hydrocarbons are diluted. While heating it in special devices, it is possible to notice, that oil alternates not due to the definite temperature, that is characteristic to the individual substances, but in wide interval of temperatures. Firstly, the substances with small molecular mass that have low temperature of boiling, are outrun due to the moderate heating, then due to the higher temperature the substances with more molecular mass begin to outrun.

Oil and coal are classified as a fossil fuel. Fossil fuels are formed when sea plants and animals die, and the remains become buried under several thousand feet of silt, sand or mud. Fossil fuels take millions of years to form and therefore oil is also considered to be an energy source.

There are several major oil producing regions around the globe. The Kuwait and Saudi Arabia's crude oil fields are the largest, although Middle East oil from other countries in the region such as Iran and Iraq also make up a significant part of world production figures. The North Sea crude oil fields are still fairly full, and are arguably the second most influential oil field in economic terms. Texas, once the world's major oil region, is now almost completely dry. In 1859 Edwin Drake sank the first known oil well, this was in Pennsylvania. Since this time oil and petroleum production figure grew exponentially. Prior to that time, petroleum was available only in very small quantities from natural seepage of subsurface oil in various areas throughout the world. However, such limited availability restricted the uses for petroleum to medicinal and special purposes. With the discovery of “rock oil” in north-western Pennsylvania, crude oil became available in sufficient quantity to inspire the development of larger-scale processing systems.

The oil structure of different deposits is not similar. But usually all of them contain such hydrocarbon types - refined and non-refined alkanes, cyclo-alkanes, aroma hydrocarbons, correlation of which varies in wide borders. The oil deposits in Kazakhstan contain more members of cyclo-alkanes with rings of five and six members. The oil from western Ukraine consists of more concentrated hydrocarbons, and from Ural - of aroma hydrocarbons. Except hydrocarbons, oil contains oxygen, sulfur and

nitrogen. Highly molecular compounds in appearance of pitch and asphaltic substances are also presented in it. Oil contains hundreds of different substances. Because oil is the mixture of hydrocarbons of different molecular mass that have different temperatures of boiling, it is divided into separate fractions (distillates), previously separating fellow-traveled gases via outrunning it in oil refinery.

Exercise 3. *Answer the following questions.*

1. What is one of the important natural sources of hydrocarbons?
2. What are physical characteristics of oil? 3. What is a structural characteristic of oil? 4. Due to what does oil alternate while heating it in special devices? 5. How are fossil fuels formed? 6. What crude oil fields are considered to be the largest? 7. What crude oil fields are arguably the second most influential oil field in economic terms? 8. When and where was the first known oil well sank? 9. What main hydrocarbon types does the oil contain? 10. How can Ukrainian oil be characterized?

Exercise 4. *Say whether the given sentences are true or false.*

1. Oil is the second important natural source of hydrocarbons. 2. Oil is a greasy burning liquid that has light-brown or almost black color with no smell. 3. Due to the structure oil is the mixture of hydrocarbons of different molecular mass, mainly liquid, in which the rigid and gaseous hydrocarbons are diluted. 4. While heating, oil alternates not due to the definite temperature, but in wide interval of temperatures. 5. Fossil fuels are formed when sea animals die, and the remains become buried under several thousand feet of silt, sand or mud. 6. The Ukrainian crude oil fields are the largest. 7. The North Sea crude oil fields are arguably the second most influential oil field in economic terms. 8. In 1959 Edwin Drake sank the first known oil well in Pennsylvania. 9. Since 1859 petroleum has become available only in very small quantities.

Exercise 5. *Match the terms with their definitions. Memorize them.*

Oil	A) a natural fuel such as coal or gas, formed in the geological past from the remains of living organisms;
Fossil fuel	B) a layer or mass of accumulated matter;
Coal	C) a combustible black or dark brown rock consisting chiefly of carbonized plant matter, found mainly in underground seams and used as fuel;
Deposit	D) a compound of hydrogen and carbon, such as any of those which are the chief components of petroleum and

	natural gas;
Hydrocarbon	E) a liquid mixture of hydrocarbons which is present in suitable rock strata and can be extracted and refined to produce fuels including petrol, paraffin, and diesel oil;
Petroleum	F) a greasy burning liquid that has dark-brown or almost black color with characteristic smell.

Exercise 6. *Fill the chart with the missing words if possible.*

Noun	Verb	Adjective	Adverb
Oil			
	To alternate		
			Smelly
		Natural	
Development			
	To limit		

Exercise 7. *Find words that go together.*

Fossil	source
Moderate	liquid
Low	color
Gaseous	smell
Molecular	mass
Characteristic	hydrocarbons
Dark-brown	temperature
Greasy	heating
Natural	fuel
Limited	part
Crude oil	field
Significant	availability

Exercise 8. *Complete the sentences.*

1. Oil is a greasy burning liquid that has … . 2. Due to the structure oil is the mixture … . 3. While heating it in the device, oil alternates … . 4. The oil structure of different deposits is … . 5. The oil deposits in Kazakhstan contain … . 6. Except hydrocarbons, oil contains … .

Exercise 9. *Match the beginnings of the sentences with their endings.*

1. Crude oil originates from	A) the oil to migrate to favourable locations.
2. Mineral oils are	B) the effect of temperature and pressure.
3. Crude oil can be refined into	C) not be location of the initial debris accumulation.
4. Coal was formed from	D) land plant debris decaying under mildly reducing atmospheres.
5. Oil migrates under	E) a wide variety of component hydrocarbons.
6. The location of the oil deposit is	F) more commonly used as machine lubricants.
7. Temperature, pressure and earth movement cause	G) ancient fossilized organic materials, such as zooplankton and algae.

Exercise 10. *Translate the text into English; give additional information about the origin of oil and its deposits in Ukraine.*

In the leading theory, dead organic material accumulates on the bottom of oceans, riverbeds or swamps, mixing with mud and sand. Over time, more sediment piles on top and the resulting heat and pressure transforms the organic layer into a dark and waxy substance known as kerogen. Left alone, the kerogen molecules eventually crack, breaking up into shorter and lighter molecules composed almost solely of carbon and hydrogen atoms. Depending on how liquid or gaseous this mixture is, it will turn into either petroleum or natural gas. Scientists aren't really sure, but they figure it probably takes hundreds of thousands of years. The scientists are convinced that it's certainly not an instantaneous process, and the rate at which petroleum is forming is not going to be the solution to the problem of petroleum supplies.

The United States' latest reminder of its petroleum dependency occurred when hurricanes Katrina and Rita struck the Gulf of Mexico, where the majority of the country's oil platforms and refineries are located. Many analysts predicted gas prices would surge to $4 and $5 per gallon, but the fears turned out to be overblown. Many of the structures suffered only glancing blows and were operating again soon afterwards.

Exercise 11. *Retell the text Oil and its Origin paying attention to the following key points:*

The discoveries that firmly established the oil industry;
The origin of oil;
Major oil producing regions around the globe;
The oil structure of different deposits;
Principal characteristics of oil.

Exercise 12. *Work in pairs and make the list of everything you know about oil as a substance. Pay special attention to the following points:*

a) its structure;
b) its origin;
c) the most influential crude oil fields;
d) the economical value of oil.

Exercise 13. *Work in pairs. You have some information about oil and its products, but you don't have the same information as your partner. Ask and answer the questions to complete the information.*

Student A

Oil is ... (What kind of liquid ...?) liquid. It has dark-brown or black color with characteristic smell.

Oil refinery complex of Ukraine consists of... (How many plants ...?) plants. They refine 60 - 62 min tons of oil in one year. The most important fractional components of primary oil refinery are ... (What...?). (What...?)... includes ether and extraction of benzene. Gas-mixture of hydrocarbons is used as fuel for... (What... for?). Gas oil is used as dilutant ... (Where ...?).

Student B

Oil is a greasy burning liquid. It has ... (What color?) color with characteristic smell.

... (What...?) consists of 6 plants. They refine ... (How many ...?) tons of oil in one year. The most important fractional components of primary oil refinery are hydrocarbon gas, benzene fraction, kerosene fraction, gas oil or diesel fuel, lubricants and remainder. Petroleum fraction includes ... (What ...?). ... (What...?) is used as fuel for reactive tractor engines. Gas is used ... (How ...?) in varnish painting industry.

Exercise 14. *Translate the sentences into English.*

1. Нафта - це масляна горюча рідина чорного чи темно-

коричневого кольору. 2. Нафта легша за воду. 3. Нафта - це суміш вуглеводню різної молекулярної маси. 4. Окрім вуглеводню, нафта включає кисень, сіру і азот. 5. Нафта- горюча корисна копалина, складна суміш вуглеводнів різних класів з невеликою кількістю органічних кисневих, сірчистих і азотних сполук, що становить собою густу маслянисту рідину, від темно-бурого до чорного кольору. 6. За молекулярну масу часто беруть середню масу молекул, що утворюють хімічну сполуку. 7. Поклади нафти на Уралі містять ароматичні вуглеводні. 8. Практично неможливо розчинити нафту у воді. 9. Нафтова індустрія бере свій початок з успішного відкриття першої нафтової свердловини в Пенсильванії.

Exercise 15. *Put the verbs in brackets into correct grammar form.*

1. The oil deposits in Ural ... (to contain) aroma hydrocarbons.
1. Ukraine ... (to consist) of more concentrated hydrocarbons. 3. The most important fractional components of primary oil refinery ... (to use) as goods products or as raw materials for next alternation. 4. Density, heat burning, fractional structure, sulfur and pitch presence ... (to be) the main indicators of fuel quality. 5. Hydrocarbons of different molecular mass ... (to have) different temperatures of boiling. 6. The quality of benzene ... (to depend) on its detonative firmness and sulfur presence.

Exercise 16. *Work in pairs and act out a dialogue between:*

a) Edwin Drake and a student of the National Aviation University;
b) Scientists from Kuwait and Saudi Arabia;
c) Scientists from Iran and Ukraine.

UNIT 14
PROPERTIES OF OIL

Exercise 1. *Learn the following words and word combinations:*

complex molecular structure - складна молекулярна структура
regardless - не зважаючи на
by weight - за вагою
viscous - в'язкий
bitumen - бітум, асфальт
paraffins - парафіни
naphthenes - нафтени
aromatics - ароматичні
endless proportions - безкінечна кількість пропорцій
to comprise - містити в собі, вміщати, охоплювати
saturated straight-chain series - насичена нерозгалужена серія
integer - ціле число
major constituent of gasoline - основний складовий бензину
residue - залишок
plastic and solid paraffin waxes - пластичні та тверді парафіни
saturated closed-ring series - насичена циклічна серія
asphalt - асфальт
asphalt-base crude - асфальтеновий сирець
abundant atomic constituent - поширена атомна складова
polycyclic molecule - полі циклічна молекула
specific gravity — питома вага
excess sulphur - надлишкова сірка
major pollutant - основний забрудник
to generate - спричиняти, викликати, породжувати
decay-resistant organic remain - органічні залишки стійкі до розпаду
siliceous skeletal fragment - крем'янисті фрагменти скелета
resins - смола
various remnants of former life - різноманітні залишки життя
closely related series - близькі серії
heavy solids - важкі тверді речовини
kerosene - гас
gas oil - газойль
lubricating oil - змащувальна олива
residual fuel oil - залишкове пічне паливо

Exercise 2. *Read and translate the text. Make the lists of physical and chemical properties of oil.*

Properties of Oil

Chemical composition

Hydrocarbon content. Although oil consists of compounds of only two elements, carbon and hydrogen, these elements form a large variety of complex molecular structures. Regardless of physical or chemical variations, however, almost all-crude oil ranges from 82 to 87% carbon by weight and 12 to 15% hydrogen. More viscous bitumens generally vary from 80 to 85% carbon and from 8 to 11% hydrogen.

Crude oil can be grouped into three basic chemical series: paraffins, naphthenes, and aromatics. Most crude oils are mixtures of these three series in various and seemingly endless proportions. No two crude oils from different sources are completely identical.

The paraffin series of hydrocarbons, also called the methane series, comprises the most common hydrocarbons in crude oil. It is a saturated straight-chain series that has the general formula C_nH_{2n+2}, in which C is carbon, H is hydrogen, and *n* is an integer. The paraffins that are liquid at normal temperatures but boil between 40° and 200°C are the major constituents of gasoline. The residues obtained by refining lower-density paraffins are both plastic and solid paraffin waxes.

The naphthene series has the general formula C_nH_{2n} and is a saturated closed-ring series. This series is an important part of all liquid refinery products, but it also forms most of the complex residues from the higher boiling-point ranges. For this reason, the series is generally heavier. The residue of the refinery process is asphalt, and the crude oils in which this series predominates are called asphalt-base crudes.

Nonhydrocarbon content. In addition to the practically infinite mixtures of hydrocarbon compounds that form crude oil, sulfur, nitrogen, and oxygen are usually present in small but often important quantities. Sulfur is the third most abundant atomic constituent of crude oils. It is present in the medium and heavy fractions of crude oils. In the low and medium molecular ranges, sulfur is associated only with carbon and hydrogen, while in the heavier fractions it is frequently incorporated in the large polycyclic molecules that also contain nitrogen and oxygen. The total sulfur in crude oil varies from below 0.05% (by weight), as in some Pennsylvania oils, to about 2% for average Middle Eastern crudes and up to 5% or more in heavy Mexican or Mississippi oils. Generally, the higher the specific gravity of the crude oil, the greater is its sulfur content. The excess sulfur is removed from crude oil during refining, because sulfur oxides

released into the atmosphere during the combustion of oil would constitute a major pollutant.

The oxygen content of crude oil is usually less than 2% by weight and is present as part of the heavier hydrocarbon compounds in most cases. For this reason, the heavier oils contain the most oxygen. Nitrogen is present in almost all crude oils, usually in quantities of less than 0.1%. Sodium chloride also occurs in most crudes and is usually removed like sulfur.

Many metallic elements are found in crude oils, including most of those that occur in seawater. This is probably due to the close association between seawater and the organic forms from which oil is generated. Among the most common metallic elements in oil are vanadium and nickel, which apparently occur in organic combinations as they do in living plants and animals. Crude oil also may contain a small amount of decay-resistant organic remains, such as siliceous skeletal fragments, wood, spores, resins, coal, and various other remnants of former life.

Physical properties

Oil consists of a closely related series of complex hydrocarbon compounds that range from gasoline to heavy solids. The various mixtures that constitute crude oil can be separated by distillation under increasing temperatures into such components as gasoline, kerosene, gas oil, lubricating oil, residual fuel oil, bitumen, and paraffin.

Exercise 3. *Answer the following questions.*

1. What are the main two elements of oil? 2. What is percentage proportion of carbon and hydrogen in crude oil? 3. What chemical series can crude oil be grouped into? 4. What does the paraffin series of hydrocarbon comprise? 5. What are the main constituents of gasoline? 6. What can you tell about naphthene series? 7. What is the third most abundant atomic constituent of crude oil? 8. What does the sulfur content in oil depend on? 9. What other elements can be found in crude oil? 10. What are physical properties of oil?

Exercise 4. *Some words have different meanings. Circle the word with the closest meaning to the underlined word.*

1. The oxygen content of crude oil is usually less than 2% by weight.
   a) meaning
   b) proportion
   c) volume
   d) capacity
2. Oil consists of closely related series of complex hydrocarbon compounds.

a) complicated c) hard
b) difficult d) composite

3. The excess sulfur is removed from crude oil during refining.
a) is moved c) is departed
b) is eliminated d) is transferred

Exercise 5. *Put the following sentences into Passive Voice.*

1. They have grouped crude oil into three chemical series. 2. They obtain the residues by refining lower-density paraffins. 3. They can remove the excess sulfur from crude oil during refining. 4. They also call the paraffin series of hydrocarbons the methane series.

Exercise 6. *Put questions to the underlined words.*

1. Crude oil is grouped into three basic chemical series. 2. The paraffin series of hydrocarbons comprises the most common hydrocarbons in crude oil. 3. Sodium chloride also occurs in most crudes. 4. Crude oil may contain a small amount of decay-resistant organic remains.

Exercise 7. *Look back into the text and find synonyms for the following words.*

1. asphalt; 2. prevalent; 3. to include; 4. component, element; 5. combination, blend, mixing; 6. main.

Exercise 8. *Read the text. Open the brackets and put the verbs into correct grammar form, pay special attention to the use of the verb 'to be'. Give the title to the text.*

Crude oil (to form) from organic material of the remains of plant and animal organisms that (to live) millions of years ago. These remains (to form) sediments at the bottom of seas, and (to become) buried under layers of sedimentary rock. They (to decay) without air, under the action of heat and pressure to form crude oil over millions of years.

The vast majority of compounds found in crude oil (to be) hydrocarbons, that (to be) molecules made up of carbon atoms combined with hydrogen atoms.

Alkanes (to be) a group of hydrocarbon molecules in which all the carbon and hydrogen atoms (to join) only by single covalent bonds. The principal source of alkane hydrocarbons (to be) crude oil. Alkanes (to know) as saturated molecules because other atoms (can, not, to add) to them. Their physical properties (to be): 1) The first four in the series (to be) all colourless smelly highly flammable gases; 2) The much larger alkanes (to be) colourless liquids and the biggest members of the series (to be)

white waxy solids; 3) They (not to be) very reactive unless burned.

Exercise 9. Say what the following numbers are connected to.

a) from 82 to 87%;
b) from 12 to 15% ;
c) from 80 to 85%;
d) from 8 to 11 %;
e) between 40° and 200°C;
f) below 0.05% (by weight);
g) about 2%;
h) to 5% or more;
i) less than 2%;
j) less than 0.1% by weight.

Exercise 10. *Read the information about oil and gas industry and memorize some other numbers connected with oil.*

There are some very big numbers in the oil and gas industry.

The world uses about 85 million barrels of oil per day. A barrel is 159 litres. So that's more than thirteen billion litres a day. Thirteen billion litres a day is about 560 million litres per hour. So oil companies need to produce a lot of oil and they need to produce it fast.

There are about 40.000 oil and gas fields in the world. Most of them are small fields, but some are very big. The biggest is the Ghawar field in Saudi Arabia. This very big field is 280 km long and 30 km wide. The Saudi national oil company, Saudi Aramco, operates the field and produces about five million barrel of oil a day. That's a lot of oil! Five million barrels is 790.000 cubic metres: 790.000 cubic metres every day. Ghawar also produces about 57 million cubic metres of natural gas per day.

Exercise 11. *Match the words that go together.*

-A-	-B-
Basic chemical	Crudes
seemingly endless	Residues
Completely	Products
Paraffin	Paraffin
the most common	temperatures
saturated straight-chain	Series
Normal	hydrocarbons
plastic and solid	Series
liquid refinery	Identical
asphalt-base	proportions
Complex	Series
physical or chemical	variations

Exercise 12. *Complete the sentences.*

1. Regardless of physical or chemical variations ... 2. More viscous bitumens generally vary from ... 3. Crude oil can be grouped into ... 4. The paraffin series of hydrocarbons ... 5. The residues obtained by refining lower-density paraffins are ... 6. The naphthene series has ... 7. The residue of the refinery process is ... 8. Sulfur, nitrogen, and oxygen are usually ... .9. The total sulfur in crude oil varies ... 10. The excess sulfur is removed ... 11. The oxygen content of crude oil is ... 12. Nitrogen is present in ...

Exercise 13. *Translate the sentences into English.*

1. Нафта є надзвичайно цінною і складається в основному зі сполук двох елементів: вуглецю та водню. 2. Вчені зазвичай класифікують неочищену нафту на три основні хімічні серії: парафіни, нафтени та ароматичні. 3. Більшість неочищеної нафти становить собою суміш трьох основних серій в різній безкінечній кількості пропорцій. 4. Метанова серія охоплює найбільш поширені вуглеводні неочищеної нафти. 5. Хоча парафіни є рідинами за нормальних температур, їх межі кипіння становлять від 40° до 200°С. 6. Нафтенова серія - є важливою частиною всіх рідких нафтопродуктів. 7. Крім вуглецю та водню неочищена нафта також містить сірку, азот та кисень. 8. Будучи третьою за поширеністю атомною складовою, сірка наявна у середніх та важких фракціях неочищеної нафти. 9. Загалом кількість сірки в неочищеній нафті може коливатися від 0.05% до 5%. 9. Оксиди сірки, що надходять у повітря під час згоряння палива, становлять основний забрудник, що викликає захворювання на рак.

Exercise 14. *Read the text and write out all prepositions used there. Say what this text is about. In what form is it written?*

You arrived by helicopter. But first, you receive safety training. Every day visitors must have safety training. Offshore work is more hazardous than onshore work, so workers must also have a medical test, do a fire fighting, and escape course before they go.

You get out of the helicopter and hold on to your hat. You are now standing on a production platform high above the water. It is as big as a football field. The top of the derrick is higher than a twenty-storey building.

Drilling platforms are not as big as this because they only do drilling. Production platforms are bigger because they do more things and must accommodate more people.

A typical production platform has four main areas above the water.

One is the accommodation area, where the workers eat and sleep. Another is the well head or drilling area. That contains the derrick, well heads, and drilling equipment. Crude oil comes up to the well heads with gas and water in it. So it goes to the process area, which separates the oil from the other things. All the areas need electricity and other utilities. The utilities area provides these: a generator makes electricity, and there is equipment for heating, ventilation, air conditioning, and water distribution.

Exercise 15. *Complete these sentences with the prepositions you have written out from the text in the Exercise 14.*

1. Heavy equipment arrives ____ boat. 2. The accommodation area is as big _____ a hotel. 3. Don't get out _____the helicopter. 4. Hold _____ the rope. 5. The lifeboats are on two sides _____the platform. 5. What are the cranes _____? 6. They are _____lifting things _____ boats. 7. The derrick is _____ the well head area.

Exercise 16. *Explain the meaning of the words and word combinations. Work in pairs and compose a dialogue using the given word combinations.*

Safety training, offshore work, onshore work, medical test, fire-fighting, escape course, production platform, derrick, drilling platform, accommodation area, well head, drilling equipment, process area, utilities.

Exercise 17. *Retell the text* ***Properties of Oil****. You may use the plan of the text given below.*

1. Chemical composition of oil:
   1.1. Hydrocarbon content:

a) The amount of carbon and hydrogen;
b) The paraffin series of hydrocarbons;
c) The naphthene series of hydrocarbons.

   1.2. Nonhydrocarbon content:

a) The amount of sulfur, nitrogen, and oxygen in oil;
b) Metallic elements of oil.

2. Physical properties of oil.

UNIT 15
CLASSIFICATION OF OIL

Exercise 1. *Learn the following words and word combinations:*

interior of the earth - надра землі
deep Antiquity - давня Античність
sulphurous - сірчаний
homologous series - гомологічний ряд
geographical source - географічне походження
unique - унікальний
light volatile fluid - летка рідина
general toxicity - загальна токсичність
weathering - погодні умови
to spread - поширюватися
odor - запах
evaporation rate - швидкість випаровування
flammable - горючий, займистий
waxy or oily feel — схожий на віск чи маслянистий на дотик
to penetrate - проникати
persistent - стійкий, сталий, постійний
tarry - тягучий, тягуча речовина
to smother - душити, задихатися
to drown - тонути, топити
to contaminate - забруднювати
to coat surface - покривати поверхню
cleanup - очищення
disputable – суперечливий
distribution - поширення
animal and vegetation residuals - тваринні та рослинні рештки
oil-and-gas production deposit - місце нафто-газового видобутку
to extract – добувати

Exercise 2. *Read and translate the text. Make the lists of basic oil components and their contents.*

Classification of Oil

Oil is the main source of fuel, lubricant and technical liquid production. Oil production from interior of the earth on its surface is known from deep Antiquity: Herodot, Aristotel, and Hypocrat mentioned oil. But the development of oil industry began much later - only since the 60s of the

19th century.

The natural oil represents a dense oily liquid. 90% of petroleum compose hydrocarbon of various compound and structure. Basic elements included into compound of oil are carbon (84%-87%) and hydrogen (12-15%). Along with carbon and hydrogen sulfur, oxygen and nitrogen are present in all oils. Nitrogen is in very little amount in oil (0.001-0.3%). And the contents of oxygen varies within the limits of 0.1... 1% and about. The contents of sulfur in petroleum changes from 0.05% up to 5% and more. It is accepted to classify petroleum according to the contents of sulfur: with the low sulfur contents - 1-st class (0.1-0.5%), sulfurous - 2-nd class (0.5-2%) and with the high sulfur contents - 3-rd class (2-10%). The most typical representatives of oil hydrocarbon are placed on the following homologous series: alkanes (paraffin) - chemical naphthenes, aromatic hydrocarbon. The hydrocarbons containing from one up to four atoms of carbon (methane, ethane, propane, butane) are gases in normal conditions.

The petroleum industry often characterizes crude oils according to their geographical source, e.g., Alaska North Slope Crude. Oils from different geographical areas have unique properties; they can vary in consistency from a light volatile fluid to a semi-solid.

There is also classification scheme that is more useful because it offers information about general toxicity, physical state, and changes that occur with time and weathering.

Class A: Light, Volatile Oils. These oils are highly fluid, often clear, spread rapidly on solid or water surfaces, have a strong odor, a high evaporation rate, and are usually flammable. Class A oils may be highly toxic to humans, fish, and other biota. Most refined products and many of the highest quality light crudes can be included in this class.

Class B: Non-Sticky Oils. These oils have a waxy or oily feel. Class B oils are less toxic. As temperatures rise, their tendency to penetrate porous substrates increases and they can be persistent.

Class C: Heavy, Sticky Oils. Class C oils are characteristically viscous, sticky or tarry, and brown or black. Flushing with water will not readily remove this material from surfaces. The density of Class C oils may be near that of water and they often sink. Weathering or evaporation of volatiles may produce solid or tarry Class D oil. Toxicity is low, but wildlife can be smothered or drowned when contaminated. This class includes residual fuel oils and medium to heavy crudes.

Class D: Nonfluid Oils. Class D oils are relatively non-toxic, and are usually black or dark brown in color. When heated, Class D oils may melt and coat surfaces making cleanup very difficult. Residual oils, heavy

crude oils, some high paraffin oils, and some weathered oils fall into this class.

These classifications are dynamic for spilled oils; weather conditions and water temperature greatly influence the behavior of oil and refined petroleum products in the environment.

The origin of petroleum is still disputable for the scientists of the entire world. Among the existing theories about the origin of petroleum and gas, the organic theory of the mixed origin received the greatest distribution. According to this theory the animal and vegetation residuals participate in petroleum and gas formation.

Ukraine is one of the most ancient oil-and-gas production deposits on the territory of Carpathians region, which began more than 120 years ago. During this time 250 million tons of petroleum with gas condensate and almost 1.2 tons of gas were extracted.

Exercise 3. *Answer the following questions.*

1. What is the main source of fuel, lubricant and technical liquid production? 2. Why do we consider that oil production from interior of the earth on its surface was known in Antiquity? 3. When did the development of oil industry begin? 4. What is the natural oil? 5. What are basic elements included into compound of oil? 6. What other elements, except carbon and hydrogen, are present in the oil? 7. How can we classify petroleum according to the contents of sulfur? 8. What hydrocarbons are gases in normal conditions? 9. What classification scheme is more useful? 10. Describe Class A (Class B, Class C, Class D) oil. . 1 1 . Why is the origin of petroleum still disputable for the scientists? 12. What theory received the greatest distribution?

Exercise 4. *Find the corresponding translation for the following terms.*

1. lubricant	a) вміст
2. origin	b) надра
3. residual	c) стародавній
4. interior	d) походження
5. ratio	e) рослинність
6. mixture	f) залишок
7. ancient	g) поклади
8. deposits	h) мастило

9. vegetation	i) співвідношення
10. production	j) видобуток
11. distribution	к)суперечливий
12. disputable	l) представник
13. contents	m) розповсюдження
14. representative	n) суміш

Exercise 5. *Fill in the gaps using the list of words and word combinations below.*

carbon	chemical naphthenes	liquid
source	Homologous series	production
nitrogen	Lubricant	hydrogen
deposits	Contents	interior

Oil is the main _____ of fuel, _____ and technical liquid production. Oil _____ from _____of the earth on its surface is known from deep Antiquity. The natural oil represents a dense oily _____. Basic elements of oil are _____ and _____. _____ is in very little amount of oil (0.001 - 0.3%). The _____of sulfur in petroleum changes from 0.05% up to 5%. The most typical representatives of oil hydrocarbon are placed on the following _____: alkanes -_____, aromatic hydrocarbon. Ukraine is one of the most ancient oil-and-gas production _____.

Exercise 6. *Match these words with their definitions*

1. Liquid	a) a gas that is an element and is the main part of Earth's air.
2. Oxygen	b) an amount or layer of a substance in a particular place.
3. Nitrogen	c) a substance which flows and is not solid or a gas.
4. Carbon	d) the things that are inside something.
5. Origin	e) ancient times.
6. Deposit	f) a gas that is lighter than air, and that becomes water when it combines with oxygen.
7. Lubricant	g) the situation or place from which something comes or
8. Antiquity	where it began to exist.
9. Ratio	h) a chemical element found in coal and petrol.
10. Hydrogen	i) a gas in the air that all living things need.
11.Contents	j) a substance that is put on things that rub together, making them move more smoothly.
	k) a relationship between 2 amounts written as two

	numbers that show how much bigger one amount is than the other.

Exercise 7. *Decide whether the following statements are true (T) or false (F) in relation to the information in the text. If you think a statement is false, change it to make it true.*

1. Oil is the main source of production of fuel, lubricant and technical liquids. 2. Oil production from interior is known from the Middle Ages, because the representatives of that time - Herodot, Aristotel, Hypocrat - mentioned oil. 3. Basic element included into compound of oil are sulfur and carbon. 4. Nitrogen is in very little amount in oil. 5. Petroleum can be classified according to the contents of carbon: 1-st class, 2-nd class and 3-rd class. 6. The hydrocarbons containing 3 atoms of carbon are gases in normal conditions. 7. The origin of petroleum is disputable for the scientists. 8. The only theory of the origin of petroleum is the organic theory of the mixed origin.

Exercise *8*. *Look back in the text and find words that have a similar meaning to:*

Petroleum, burnable, questionable, to take part, to include, together with, residue, fluid, effect, polluted

Exercise 9. *Put all types of questions to the following sentences.*

1. Development of oil industry began much later.
2. The natural oil represents a dense oily liquid.
3. The origin of petroleum is still disputable for the scientists.

Exercise 10. *Put special questions to the underlined words*.

1. According to this theory the animal and vegetation residuals participate <u>in petroleum and gas formation</u>.
2. <u>90%</u> of petroleum compose hydrocarbons of various compound and structure.
3. <u>The organic theory of the mixed origin</u> received the greatest distribution.
4. Basic elements of oil are <u>carbon and hydrogen</u>.

Exercise 11. *Put the verbs in brackets into correct grammar form*.

1. The main source of fuel, lubricant and technical liquids production ... (to be) oil. 2. Herodot, Aristotel, Hypocrat ... (to mention) oil in Antiquity. 3. The development of oil industry ... (to begin) in the 19th

century. 4. The natural oil ... (to represent) a dense oily liquid. 5. Oil ... (to include) carbon, hydrogen, sulfur, oxygen, nitrogen, etc. 6. The contents of sulfur in petroleum ... (to be) 0.05% - 5%. 7. The hydrocarbons containing 1- 4 atoms of carbon ... (to be) gases in normal conditions. 8. The scientists still ... (to dispute) about the origin of petroleum. 9. Ukraine ... (to have) deposits on the territory of Carpathians region.

Exercise 12. *Form the nouns from the following verbs using suffixes -tion, -ant, -ment, etc. If you have any difficulties look for these nouns in the text.*

To classify, to develop, to distribute, to form, to modify, to lubricate, to produce.

Exercise 13. *Make up plural form for the following nouns.*

Oil, source, compound, representative, theory, residual, process, substance, deposit, mixture, scientist, element, naphthene, condition, mineral.

Exercise 14. *Write out ail compound nouns from the text. Translate them into Ukrainian.*

Example: liquid production - виготовлення рідини
oil production - вилучення нафти

Exercise 15. *Translate into English.*

1. Нафта - це основне джерело виготовлення палива, мастил, тощо. 2. Вилучення нафти з надр землі відомо з античності. 3. Розвиток нафтової промисловості розпочався в 60рр. XIX ст. 4. Природна нафта - це густа масляна рідина. 5. До складу нафти входять вуглець, водень, сірка, кисень та азот. 6. Відповідно до вмісту сірки, нафту класифікують на нафту 1-го класу (з низьким вмістом сірки), 2-го класу (сірчаний) та 3 класу (з великим вмістом сірки). 7. Походження нафти все ще суперечливе для вчених всього світу. 8. Серед існуючих теорій найбільшого розповсюдження здобула теорія змішаного походження. 9. Відповідно до цієї теорії тварини і рослини беруть участь у формуванні газу і нафти. 10. Усі горючі матеріали, які беруть участь у формуванні нафти, називаються каустобіолітами.

Exercise 16. *Insert the words and word combinations into the text according to its context.*

Variations, qualities, one oil field, properties, structure, influence, odour, crude oil, products, classified, quality of the products, in terms of, as

'heavy', different geographical locations, an API gravity, sulfur content, 'intermediate', acidic material, 'sour'

The different Types of Crude oil have _____ in viscosity and appearance from _____ to another. The variations range in _____, color and in the basic properties and _____. While all Types of _____ are basically hydrocarbons, there are differences in their _____ , especially in the variations in the molecular_____ . The many variations may also _____ the suitability of the different types of crude oil for particular _____ and the resulting _____ . The different Types of crude oil are _____ based on the American Petroleum Gravity (API) gravity and viscosity. The properties may vary _____ proportion of hydrocarbon elements, sulfur content etc. as it is extracted from _____ all over the world. If the API gravity of the crude oil is of 20 degrees or less, it is graded _____ , those with _____ of 40.1 degrees or greater than that is known as 'light' and if the oil ranges between 20 and 40.1 degrees, it is graded as _____ . Classifications are made based on the _____ as well. Crude oil with low content of sulfur means 'sweet' and the presence of high content sulfur is known as _____ . The purity of crude oil increases or decreases based on the sulfur content as sulfur is an _____.

Exercise 17. *Put the sentences into wright order to make the text. Then work in teams and add to the text given below more information about classification of oil.*

(1) The viscosity and relative weight of crude oil varies and it can exist in either liquid or solid state.

(2) It can be light or heavy, sticky or non-sticky and for some types of crude oil, heavy flushing is required to remove it from the surfaces.

(3) Crude oil otherwise known as petroleum is a composition of hydrocarbons and other compounds which is usually yellow or black in color.

(4) It is extracted from the earth, formed naturally from the fossil of animals and plants.

(5) Saudi Arabia, Kuwait, Qatar are major crude oil producing countries.

(6) The physical properties play a significant role in simplifying the refinement process for the conversion of crude oil into various end products.

UNIT 16
MAIN OIL REFINERY PROCESSES

Exercise 1. *Learn the following words and word combinations:*

to meet the business objectives - задовольняти підприємницькі цілі basic processing unit - основні переробні установки
separating - відокремлення, сепарація
converting - перетворення, конверція
purifying - очищення
fractional distillation - фракційна перегонка
distiller - дистилятор
subsequent processing - подальша обробка
reformer - установка для риформінгу
alkylation - алкілування
coker - установка для коксування
to withdraw - забирати, витягувати
storage tank - бак для зберігання
to pump - качати, викачувати
constant rate - постійна швидкість
heat exchanger - теплообмінник
furnace - піч, топка
fractionating column - фракційна ректифікаційна колона
fractionating tray - тарілка ректифікаційної колони
to pipe - пускати трубами
slot - щілина, отвір
sidestream - потік, проміжний продукт
light straight-run naphtha - світлий прямогінний лігроїн
to adjust - пристосовувати
bitumen - бітум, асфальт
feedstock - сировина
lubricant - мастило
liquefied petroleum gas - зріджений нафтовий газ
to maintain - підтримувати, зберігати
wax precipitant - восковий осад
metal scraper - залізна скоба
yield - вихід, видобуток
impurity - домішка
antiknock additives - антидетонаційні присадки
exhaust-treatment system - система для очистки від вихлопних газів
noxious emissions - шкідливі виділення

Exercise 2. *Read and translate the text. Make the lists of basic oil refinery processes and their characteristic features.*

Main Oil Refinery Processes

Each refinery is uniquely designed to process specific crude oils into selected products. In order to meet the business objectives of the refinery, the process designer selects from an array of basic processing units. In general, these units perform one of three functions:

1) separating the many types of hydrocarbon present in crude oils into fractions of more closely related properties,
2) chemically converting the separated hydrocarbons into more desirable reaction products, and
3) purifying the products of unwanted elements and compounds.

Separation

Fractional distillation

The primary process for separating the hydrocarbon components of crude oil is fractional distillation. Crude oil distillers separate crude oil into fractions for subsequent processing in such units as catalytic reformers, cracking units, alkylation units, or cokers.

Crude oil is withdrawn from storage tanks at ambient temperature and pumped at a constant rate through a series of heat exchangers in order to reach a temperature of about 120° C. A controlled amount of fresh water is introduced, and the mixture is pumped into a desalting drum, where it passes through an electrical field and a saltwater phase is separated. The desalted crude oil passes in a furnace. There it is heated to a temperature between 315° and 400° C, depending on the type of crude oil and the end products desired. A mixture of vapour and unvaporized oil passes from the furnace into the fractionating column, a vertical cylindrical tower containing 20 to 40 fractionating trays spaced at regular intervals.

The oil vapours rise up through the column and are condensed to a liquid in a water- or air-cooled condenser at the top of the tower. A small amount of gas remains uncondensed and is piped into the refinery fuel-gas system. Part of the condensed liquid is pumped back into the top of the column and descends from tray to tray, contacting rising vapours as they pass through the slots in the trays. The liquid progressively absorbs heavier constituents from the vapour and gives up lighter constituents to the vapour phase. Condensation and reevaporation takes place on each tray.

Intermediate products, or “sidestreams,” are withdrawn at several points from the column. Typical boiling ranges for various streams are as

follows: light straight-run naphtha (overhead), 20°-95° C ; heavy naphtha (top sidestream), 90°-165° C; crude kerosene (second sidestream), 150°-245° C; light gas oil (third sidestream), 215°-315° C.

Vacuum distillation

The principles of vacuum distillation resemble those of fractional distillation, except that larger-diameter columns are used.

The primary advantage of vacuum distillation is that it allows distilling heavier materials at lower temperatures, thus avoiding thermal cracking of the components. Firing conditions in the furnace are adjusted so that oil temperatures usually do not exceed 425° C. The residue remaining after vacuum distillation, called bitumen, may be further blended to produce road asphalt or residual fuel oil, or it may be used as a feedstock for thermal cracking or coking units. Vacuum distillation units are essential parts of the many processing schemes designed to produce lubricants.

Absorption

Absorption processes are employed to recover valuable light components such as propane and butane. These volatile gases are bubbled through an absorption fluid, such as kerosene or heavy naphtha, in equipment resembling a fractionating column. The light products dissolve in the oil while the dry gases (hydrogen, methane, ethane, and ethylene) pass through undissolved. The light product vapours are condensed for recovery as liquefied petroleum gas (LPG).

Crystallization

The crystallization of wax from lubricating oil fractions is essential to make oils suitable for use. A solvent is first added to the oil, and the solution is chilled to about -20° C. The function of the benzene is to keep the oil in solution and maintain its fluidity at low temperatures, whereas the methyl ethyl ketone acts as a wax precipitant. Rotary filters deposit the wax crystals on a special cloth stretched over a perforated cylindrical drum. A vacuum is maintained within the drum to draw the oil through the perforations. The wax crystals are removed from the cloth by metal scrapers.

Conversion

The separation processes described above are based on differences in physical properties of the components of crude oil. All petroleum refineries throughout the world employ at least crude oil distillation units to separate naturally occurring fractions for further use, but those which employ distillation alone are limited in their yield of valuable transportation fuels. By adding more complex conversion processes that

chemically change the molecular structure of naturally occurring components of crude oil, it is possible to increase the yield of valuable hydrocarbon compounds.

Purification

Before petroleum products can be marketed, certain impurities must be removed. The most common impurities are sulfur compounds. Apart from their foul odour, sulfur compounds are technically undesirable. In motor and aviation fuels they reduce the effectiveness of antiknock additives and interfere with the operation of exhaust-treatment systems. In diesel fuel they cause engine corrosion and complicate exhaust-treatment systems. Most crude oils contain small amounts of hydrogen sulfide, but these levels may be increased by the decomposition of heavier sulfur compounds during refinery processing. In order to minimize noxious emissions, most refinery fuel gases are desulfurized.

Other undesirable components include nitrogen compounds, which poison catalyst systems, and oxygenated compounds, which can lead to colour formation and product instability.

Exercise 3. *Answer the following questions.*

1. What is refinery designed for? 2. What are the main refinery processes? 3. What do crude oil distillers separate? 4. Tell about the processes after crude oil is withdrawn from storage tanks. 5. What happens with a small amount of uncondensed gas? 6. What distinguishes fractional distillation from simple distillation columns? 7. Where does unvaporized oil entering the column flow? 8. What is the difference between vacuum and fractional distillation? 9. How may bitumen be used? 10. What is the purpose of absorption? 11. What is the purpose of crystallization?

Exercise 4. *Match these words with their definitions.*

1. Refinery	a) a liquid that can change a solid substance into liquid;
2. Fractional distillation	b) plant, designed to process specific crude oils into selected products;
3. Sidestreams	c) process employed to recover valuable light components from the vapors that leave the top of crude-oil or process-unit fractionating columns within the refinery;
4. Bitumen	d) the primary process for separating the hydrocarbon components;
5. Absorption	
6. Solvent	

e) intermediate products;
f) the residue remaining after vacuum distillation.

Exercise 5. *Decide whether the following statements are true (T) or false (F) in relation to the information in the text or the information is not enough to make a decision (?). If you think a statement is false, change it to make it true.*

1. Fractional distillation units are much larger than modern crude oil distillation units employed in chemical and other industries.
2. The liquid absorbs heavier constituents from the vapour and gives up lighter constituents to the vapour phase.
3. In comparison with vacuum distillation fractional distillation allows for distilling heavier materials at lower temperatures.
4. The separation processes are based on differences in physical properties of the components of crude oil.
5. The crystallization of wax from lubricating oil fractions is essential to make oils suitable for use.

Exercise *6*. *Restore the order of the sentences to give the meaning to the text.*

Refinery Operations

(1) Once the basic products are distilled and cracked, they still may not have the ideal formulation.
(2) Reforming may be used to adjust their composition.
(3) Refinery operations fall into three categories: physical separation (distillation, solvent extraction, desulphurisation), breaking down (cracking, visbreaking, coking) and rebuilding processes (reforming).
(4) The first process is distillation.
(5) Every crude oil has very different characteristics.
(6) It certainly contains a complex mixture of many different chemicals which must be separated and treated.
(7) The different components of the mixture are separated in a distillation column by their boiling range.
(8) Then the heavy fuel oils are cracked into the lighter components.
(9) Cracking is the process of reducing the size of the molecules to form lighter ones.

Exercise 7. *Fill in the gaps using the list of words and word combinations below.*

separation	hydrocarbon	Sulfur
conversion	purification	Absorption

Basic refinery processes include separation, conversion and …. The function of the separation process is to separate many types of ... present in crude oil into fractions. The main processes of separation are distillation, ... and crystallization. ... processes are based on differences in physical properties of the components of crude oil. ... processes chemically change the molecular structure of the components of crude oil. In diesel fuel ... compounds can cause engine corrosion and complicate exhaust-treatment systems.

Exercise *8. Put the verbs in brackets into correct grammar form.*

1. Basic refinery processes ... (to perform) three functions. 2. A crude oil distiller ... (to separate) crude oil into fractions. 3. As demand for automotive fuel rose, methods for continuous distillation of crude oil ... (to develop). 4. Reflux ... (to pump) back into the top of the column and ... (to descend) from tray to tray. 5. In order to reduce the partial pressure of the hydrocarbons and assist in the separation steam ... (to inject) into the bottom of the column.

Exercise 9. *Change the sentences with Passive Voice into the sentences with Active Voice. Add more information about the processes with the help of which the following actions are possible to make the sentences sound right.*

1. The crude oil is vapourised and passed into a vertical column. 2. When heavy petroleum is heated above its decomposition temperature, the molecules are broken down and rearranged. 3. Gas and petroleum coke are also formed. 4. The heavy oil is heated to a lower temperature under pressure with a catalyst. 5. Naphthalenes are converted to the corresponding alkanes and alkenes. 6. Care must be taken to minimize the formation of excessive coke. 7. Conditions can be adjusted to either produce gas oil or coke as the main product.

Exercise 10. *Put all types of questions to the following sentences.*

1. The earliest refineries employed simple distillation to separate the various constituents of petroleum. 2. Naphtha was primarily applied as a solvent. 3. Methods for continuous distillation of crude oil were developed.

Exercise 11. *Translate the sentences into English.*

1. Кожен переробний завод спроектований таким чином, щоб переробляти необроблену нафту на певні нафтопродукти. 2. Основні переробні установки виконують три основні функції: виокремлення окремих видів вуглеводнів, їх перетворення на певні продукти та очищення отриманих продуктів від небажаних домішок. 3. Залежно від типу нафти та від бажаних продуктів сиру нафту нагрівають від 315 до 400 градусів. 4. Фракційна ректифікаційна колона представляє собою циліндричну вежу 45 метрів заввишки, яка містить від 20 до 40 ректифікаційних тарілок, розміщених через однакові проміжки. 5. Рештки, що залишаються на дні колони, використовуються для додавання до промислових палив. 6. Основні принципи вакуумної перегонки нагадують принципи фракційної перегонки. 7. Процеси поглинання використовуються для добування цінних легких компонентів, таких як пропан чи бутан. 8. Основна функція бензолу - це підтримування текучості палива за низьких температур.

Exercise 12. *Match the given descriptions with the main refinery processes.*

1.Hydroforming (Hydrocracking)	A) is the oldest? simplest but least effective method where the molecules are broken down by the action of heat. When heavy petroleum is heated above its decomposition temperature, the molecules are broken down and rearranged. This results in an increased yield of gasoline. Gas and petroleum coke are also formed.
2. Catalytic reforming	B) is a sophisticated method. Catalysts are usually natural or artificial clays. More recently zeolites are used due to higher activity. The catalysts are in the form of pellets, beads or powder depending on the process.
3. Coking	C) is the process used to crack the remaining very heavy residues left from the refining process. These substances are very viscous and are not easily transported. It is possible to subject the substances to a mild cracking which breaks down enough of the heavier compounds to lower boiling point, less viscous ones to greatly reduce the need for gas oil.
4. Catalytic Cracking	D) is undertaken in certain refineries to break
5. Visbreaking	

6. Thermal Cracking	down the final residuals to coke. Under severe temperature conditions of thermal cracking, the liquid feed is converted to gas, naphtha, fuel oil, gas oil and coke. Conditions can be adjusted to either produce gas oil or coke as the main product. E) is similar to thermal cracking in principle and used to improve of octane number. Temperature and pressure are generally higher than for thermal cracking. Products of the process are gasoline, residual oil and gases. The amount of gasoline is dependent on temperature but also on the catalyst. Catalyst not only accelerate the process but increase the yield of reformate. F) is the process whereby the reduction in H to C ratio of a high boiling point product. As the number of C atoms in the molecule increases so its hydrogen content falls. Heavy, high boiling point fractions may be cracked in the presence of high pressure hydrogen with catalyst to result in saturated, lower boiling point products.

Exercise 13. *Read the text and put ten special questions to its content.*

Crude oil is refined by a process called fractionation or distillation. The word refining means 'removing impurities or unwanted substances'. The various constituents are separated in a fractionating column. The process starts by heating the crude oil and then collecting the different gas and vapour fractions as they condense at different levels in the column, with the heavier fractions being taken off at the bottom. The process is improved be reflux, that is, feeding some of the light liquids back down the column, to give more efficient separation. Crude oil is separated into around eight different fractions comprising hundreds of different molecules.

The lightest fraction, petroleum gas, contains methane, ethane, propane, and butane. Propane and butane are eventually stored under pressure in small cylinders and sold for domestic heating and cooking. Petroleum gas is also used as the feedstock for plastics and fertilizers.

The next fraction, naphtha, is a volatile liquid processed in the

refinery to make heavier molecules which are blended with the next heaviest and most valuable fraction, petrol, also called gasoline.

Heavier fractions are used for jet fuels, diesel fuels, lubricating oils, and different grades of heating oil. The very heavy materials left are residuals which are separated as bitumen and coke. They can also be processed to break up the molecules and to add hydrogen obtained from the lighter fractions. In this way, the value of the products is optimized to maximize production of high-grade petrol.

The main impurity separated from oil is sulphur. Sulphur is processed in the refinery and sold to the chemical industry.

After blending, products are stored in tank farms and distributed by pipelines, road tankers, and ships to oil depots and by road tankers to filling stations.

Exercise 14. *Complete the sentences according to the text Ex. 13.*

1. Fractionation is a ... 2. Fractionating column is a ... 3. Eight different fractions can be ... 4. Petroleum gas is ... 5. Naphtha is ... 6. Jet fuels, diesel fuels, lubricating oils are made ... 7. To maximize production of high-grade petrol it is necessary ... 8. Sulphur is considered to be ... 9. Oil products are distributed by ...

Exercise 15. *Fill in the gaps with the verbs below. Define their voice.*

Bring, is connected, is hidden, is refined, is returned, is stored, manage, take, travels

1. This is the jetty. Tankers _____ crude oil to the refinery. They unload the crude oil there. 2. The crude oil _____ along the pipes into the tanks at the tank farm. 3. The crude oil _____ in the tanks until it is refined. Some of them are 80 metres high. There are over 200 steps to the top. 4. The oil _____ in the distillation towers in the main refinery. 5. The pipes take the products out of the refinery. Some of the pipes _____ kerosene to the airport. The refinery uses river water for cooling the machinery. The used water _____ to the salt marsh. It is often cleaner when it is returned than it was when it was taken from the river. 7. The refinery _____ to the main road. All of the workers come and go that way. Some of the products leave that way in tankers. 8. The admin block is where the offices are. The people who work there _____ the people and the machinery at the refinery. 9. The refinery _____ from the neighbouring village by trees.

Exercise 16. *Retell the text* ***Main Oil Refinery Processes*** *paying attention to the following key points:*

- Three functions of basic processing units;
- Fractional distillation;
- Vacuum distillation;
- Absorption;
- Crystallization;
- Conversion;
- Purification.

Exercise 17. *Imagine that you are a worker at the refinery in Asia-Pacific region and your task is to run a tour for students about main refinery processes and the whole refinery complex. Use your knowledge of the lesson.*

UNIT 17
REFINERY INDUSTRY

Exercise 1. *Learn the following words and word combinations*:
petroleum - нафта, бензин
to be uniquely configured - бути унікально спроектованим
to survey - проводити дослідження, досліджувати
available raw material - доступна сировина
diesel oil — дизельне масло
fuel oil - паливне масло
to store - зберігати
pipeline - трубопровід
to manufacture - виробляти
next alternation - наступна (подальша) переробка
remainder - залишок
black oil - нафтовий залишок, мазут
petroleum ether - нафтовий ефір
dilutant - розчинник
fabric - тканина
detonative firmness - детонаційна стійкість
octane number - октанове число
catalytic splitting - каталітичне розчеплення
density - густина
heat burning - теплота згоряння
pitch presence - присутність смоли
varnish painting industry-лако-фарбова індустрія
viscosity - в'язкість
flashing temperature - температура запалювання
estimation - оцінка
friction - тертя
rigid surface - жорстка поверхня
lubricative - мастильний
to be subjected - бути підданим чомусь
to out-tune - піддавати
industrial kiln - промислова піч для кальцинації

Exercise 2. *Read and translate the text. Make the plan of the text.*

Refinery Industry

Each petroleum refinery is uniquely configured to process a specific raw material into desired products. In order to determine which

configuration is most economical, engineers and planners survey the local market for petroleum products and assess the available raw materials.

An oil refinery turns crude oil into petroleum gas, petrol/ gasoline, kerosene, diesel oil, fuel oil, asphalt/ bitumen, and many other products. First, the crude oil is pumped into the furnace, where it is boiled. Next the boiling oil enters the bottom of the distillation tower. Boiling separates the crude oil into fractions. Fraction means part. The fractions of crude oil are products with different boiling points: petroleum gas, petrol, and so on. The lightest product, petroleum gas, rises to the top. The heaviest products, like asphalt, sink to the bottom. After the products are separated, they are piped out of the tower. The different products are stored in the tanks in the refinery. Finally, they are taken out of the refinery by tanker lorry, rail tanker, boat, or pipeline.

Oil refinery complex of Ukraine consists of 6 plants that work due to two schemes: fuel; fuel-lubricant. They refine 60 - 62 min tons of oil in one year, and manufacturing more than 50 types of oil products. The most important fractional components of primary oil refinery that are used as goods products, or serve as raw materials for next alternation are:

- hydrocarbon gas (propane, butane);
- benzene fraction, temperature of boiling till 200 °C;
- kerosene fraction, temperature of boiling 220 - 275 °C;
- gas oil or diesel fuel, temperature of boiling 200 - 400 °C;
- lubricants, temperature of boiling 300 °C;
- remainder (black oil).

All these fractions are used for obtaining of light oil products.

The petroleum fraction includes so called petroleum ether and extractional benzene. Petrol that dominantly contains hydrocarbons in large quantities is used as aviation and automobile fuel or is also used as a dilutant of oils, caoutchouc, for cleaning oil fabric. The manufacturing of benzene makes 25 - 50% of all types of all products. The quality of benzene depends on its detonative firmness and sulfur presence. As a rule for manufacturing of petroleum with high detonative firmness, a highly octane benzene fractions are used, that are obtained as a result of secondary refining processes.

Gas-mixture of hydrocarbons is used as fuel for reactive tractor engines and also for everyday needs. It is produced on the base of directly outrunning fractions of oil and gas oils of catalytic splitting. The main indicators of fuels quality for reactive engines are density, heat burning, fractional structure, and sulfur and pitch presence. The significant part of kerosene is listed to lower hydrocarbons. Gas oil is used as fuel for diesel

engines, and also as a dilutant in varnish painting industry. The basic exploitational characters of gas oil are speed of burning, fractional structure, viscosity, flashing temperature, thickening, the content of pitch like and corrosion active compounds.

Diesel fuels that contain lots of alkanes and small quantity of arenes have the best speed of burning. The estimation of fuel burning is realized with the help of octane number. Normal start and smooth work of diesels is provided by using fuel with octane number being not less than 45.

The lubricants or oil, that include hydrocarbons, are cleaned and used for lubrication of mechanisms, with the purpose of reducing of friction between rigid surfaces of moving particles of different engines, machines. Lubricants are mixtures of liquid highly boiling fractions. Due to the region of using they are divided into special and lubricative. Lubricative are divided into industrial, engine, vacuum, energetic, cylindrical, transmission, axelic, hydraulic.

After outrunning of oil of light products the viscous black liquid black oil remains. As a rule, black oil is subjected to another alternation by the way of heating. To avoid decomposition, it is out-tuned under low pressure, emitting lubricants. Except alternation on lubricant, black oil is subjected to chemical alternation on petrol, and also is used liquid fuel in vapor boilers of thermal plants, and different industrial kilns. For characteristic of exploitational properties of black oil such indicators are used: density, viscosity, water and carbon containing.

From black oil of some oil types, vaseline and paraffin are produced. The black oil remain is called oil hydron. Vaseline is used in medicine. It consists of mixture of liquid and rigid hydrocarbons. Paraffin is used for producing of higher carbon acids, for producing pencils, matchers, and candles. It consists of mixture of rigid hydrocarbons.

Exercise 3. *Answer the following questions.*

1. How is each petroleum refinery configured? 2. What products do an oil refinery turn crude oil into? 3. How is the crude oil separated into fractions? 4. What is the lightest oil product? 5. What is the heaviest oil product? 6. What does oil refinery complex of Ukraine consist of? 7. What does the petroleum fraction include? 8. What do you know about lubricants? 9. What indicators are used for characteristic of exploitational properties? 10. What is black oil? What is produced from it?

Exercise 4. *Translate the following words and word combinations into English.*

Масляна горюча рідина, розчинний, молекулярна маса, кисень, сірка, азот, смола, ефір, газойль, доля (частка), температура кипіння, мазут, залишок, легкий нафтопродукт, каучук, пропан, бутан, бензол, дизельне паливо, октанове число, реактивний двигун, в'язкість, тертя, парафін, сировина, забруднення, гідравлічний.

Exercise 5. *Fill in the gaps with the following words.*

Pitch	fraction	varnish
Hydrocarbons	engines	water
Lubricants	caoutchouc	liquid
Sources	dilutant	density
Aviation	gas oil	

Oil is one of the important natural _____ of hydrocarbons. It is a greasy burning _____ that has dark-brown or black color with characteristic smell. It is lighter than _____, practically not dilutable in it. Oil is the mixture of _____ of different molecular mass. The petroleum _____ includes ether and extractional benzene. Petrol is used as _____ and automobile fuel. It is also used as a _____ of oils, _____ , for cleaning oil fabric. The main indicators of fuel quality for reactive engines are ____ , heat burning, fractional structure, and sulfur and _____ presence. _____ is used as fuel for diesel _____ , and as a dilutant in _____ painting industry. Due to the region of using _____ are divided into special and lubricative.

Exercise *6*. *Complete the sentences.*

1. Each petroleum refinery is uniquely ... 2. An oil refinery turns crude oil into ... 3. First, the crude oil is ... 4. Next the boiling oil enters ... 5. The fractions of crude oil are ... 6. The different products are stored in ... 7. Oil refinery complex of Ukraine consists of ... 8. The most important fractional components of primary oil refinery are ... 9. The petroleum fraction includes ... 10. The quality of benzene depends on its ... 11. The main indicators of fuel quality for reactive engines are ... 12. Gas oil is used ... 13. Lubricants are mixtures ... 14. Vaseline and paraffin are produced ...

Exercise 7. *Put all types of questions to the following sentences.*

1. The oil structure of different deposits is not similar. 2. Oil refinery complex of Ukraine consists of six plants. 3. Vaseline is used in medicine. 4. The basic exploitational characteristics of gas oil are speed of burning, viscosity and so on. 5. Ukrainian 6 plants refine 60 - 62 mln tons of oil per year.

Exercise *8. Translate the following sentences into Ukrainian in written form. Pay attention to the constructions with adjectives: (more ...)/-er ... than, the -er/ more ... the -er/ more ... (чим ...тим ...). Make up your own sentences with these constructions.*

1. The higher density the bigger quantity of fuel will be possible to load into container of flying vehicle.
2. The higher pressure of vapors, the better fuel evaporation will be.
3. Oil is lighter than water, practically not dilutable in it.

Exercise 9. *Fill in the gaps with correct prepositions if they are necessary (to, by, into, of from, with, for).*

1. Vaseline and paraffin are produced ... black oil of some oil types. 2. Paraffin is used ... producing of higher carbon acids, ... producing pencils, matches, candles. 3. Black oil is subjected ... another alternation ... the way of heating. 4. Oil is the mixture ... hydrocarbons of different molecular mass. 5. Substances ... small molecular mass have low temperature of boiling. 6. The oil from western Ukraine consists ... more concentrated hydrocarbons. 7. Except hydrocarbons, oil contains ... oxygen, sulfur and nitrogen. 8. Lubricative are divided ... industrial, engine, vacuum, energetic, cylindrical, and hydraulic.

Exercise 10. *Rewrite the following sentences in Passive Voice.*

1. They refine 60 - 62 mln tons of oil in one year. 2. They use these fractions for obtaining of light oil products. 3. They clean and use lubricants for lubrication of mechanisms. 4. They divide lubricative substance into industrial, vacuum, energetic. 5. They produce vaseline and paraffin from black oil.

Exercise 11. *Put the verbs in brackets into correct grammar form.*

1. Naphthalenes (to convert) to the corresponding alkanes and alkenes. 2. Catalyst regeneration (to be) vital to the economics of the process. 3. The most important fractional components of primary oil refinery (to use) as goods products or as raw materials for next alternation. 4. Density, heat burning, fractional structure, sulfur and pitch presence (to be) the main indicators of fuel quality. 5. Hydrocarbons of different molecular mass (to have) different temperatures of boiling. 6. The quality of benzene (to depend) on its detonative firmness and sulfur presence. 7. Care (must/ to take) to minimize the formation of excessive coke. 8. Very heavy fuel oils (to be) only valuable in power generation where they (to

compete) with the cheaper alternative coal. 9. In Venezuela, the oil (to be) relatively close to the surface and hence all the lighter fractions (to evaporate) off over the years leaving the heavier residue.

Exercise 12. *Circle the correct answer choice for each question.*

1. Oil is lighter than water, practically not... in it.
   a) dilute; b) dilutant; c) dilutable.
2. The rigid and gaseous hydrocarbons ... in oil.
   a) dilute; b) dilutant; c) dilutable.
3. Petrol is used as a ... of oils, caoutchouc, for cleaning oil fabric.
   a) dilute; b) dilutant; c) dilutable.
4. The ... is a mixture of liquid highly boiling fractions.
   a) lubrication; b) lubricant; c) lubricative.
5. These materials are used for ... of mechanisms in order to reduce the friction between rigid surfaces.
   a) lubrication; b) lubricant; c) lubricative.
6. Due to the region of using lubricants are divided into special and ... .
   a) lubrication; b) lubricant; c)lubricative.

Exercise 13. *Translate into English paying special attention to the use of Passive Voice.*

1. Асфальт використовується для покрівлі будинків. 2. Зріджений нафтовий газ часто використовується для заправки певних видів автомобілів. 3. Неочищена нафта надходить зі свердловини до нафтопереробного заводу, де її переганяють на легкі та важкі нафтопродукти, такі як бензин та асфальт. 4. Кожен нафтопереробний завод сконструйований таким чином, щоб переробляти сировину на певні нафтопродукти. 5. Нафтопереробний комплекс України складається із 6 заводів, які переробляють 60 - 62 млн. тонн нафти на рік. 6. Бензинова частка вміщує нафтовий ефір та бензол. 7. Бензин використовується як паливо для літаків та автомобілів; ним також розбавляють масла, каучук. 8. Найкращу швидкість спалювання мають дизельні палива, які складаються з великої кількості алканів та невеликої кількості аренів. 9. Для характеристики експлуатаційних властивостей мазуту використовуються такі індикатори: густина, в'язкість, вміст води і вуглецю. 10. Вазелін широко використовується в медицині, а парафін використовується для виготовлення олівців, сірників та свічок.

Exercise 14. *Read the given paragraphs and arrange them into the right order to make the text*.

What is the oil and gas industry?

(1) Refinery capacities and throughputs in the West have stayed fairly constant over the past decade, with operations concentrating on improved efficiency.

(2) The UK oil and gas industry is Britain's greatest industrial success story in the last 50 years. Oil and gas provide energy and essential chemicals for the transport, industry and homes, and earn valuable tax and export revenues to support the British economy.

(3) Refineries employ engineers, designers, technicians, and administration personnel who maintain and improve the plant.

(4) However, there has been a large increase in refinery capacity in China, the Asia-Pacific region, and Africa as these producing countries have begun to build and operate their own refineries.

(5) It is an exciting place to work, even though the environment is somewhat noisy and smelly. With the high temperatures and pressures, and the explosive and flammable nature of the materials, a refinery is a hazardous place and so a great of attention is paid to health, safety, and protecting the environment.

Exercise 15. *Match the names of the positions with the descriptions of the duties the people who obtain them perform to find out who are the* people in a typical drilling crew.

1. Roustabouts	A) work high up on the monkey board about 25 metres above the floor. They guide the top part of the drill pipe. At other times, they help the mud engineers: they check the mud and maintain the pump. The mud must not be too thick or too thin, and the pump must keep working;
2. Roughnecks	
3. Derrickmen	B) supervise and train the drilling crew, and they control the drilling equipment. For example, they operate the motor that lifts the drill pipes. They control the speed of the drill. On very modem rigs, they sit in a special chairs that have joystick controls and display screens;
4. Drillers	
5. Rig managers or toolpushers	C) are like roustabouts, but they are more skilled. They work on the drilling floor. They connect the heavy drill pipes and put them into the hole, or they disconnect the pipes as they come up out of the hole;

	D) the most senior persons in the drilling crew. They are usually the oldest and most experienced people. They make sure the crew has all the right equipment and are responsible for their safety and for paperwork; E) are often the youngest people in a drilling crew. They clean, maintain, and move equipment and help the other workers. If they want better jobs, they work hard, listen carefully, and learn fast.

Exercise 16. *Answer the questions.*

Which person/ people

a) are usually the youngest and the most junior?
b) is usually the oldest and the most senior?
c) need to be strong? Why?
d) is not afraid of high places?
e) must watch gauges and screens carefully? Why?
f) needs a desk and a telephone? Why?

UNIT 18
OIL PRODUCTS AND THEIR USES

Exercise 1. *Learn the following words and word combinations:*

to consume - споживати
refinery desulfurization
facilities - установки для десульфуризації нафтопродуктів
heating value - теплотворна здатність
periodic variability - періодична мінливість
portable fuel - легке паливо
domestic heating - опалення будинків
illuminant джерело світла, освітлювач
to diminish - зменшувати, знижувати
jet engine - реактивний двигун
flash point specification - точка спалаху
fire hazard - небезпека пожежі
handling - поводження
high-altitude flight - політ на висоті
conventional
freeze-point specification - умовна точка замерзання
to induce - спричиняти, викликати
compression - стиснення, тиск
to inject - впорскувати, вводити
cetane rating - цитанова частка
marine diesel oil - дизельне паливо для морських потреб
to command - коштувати, встановлювати
to foul - забруднювати, засмічувати
to restrict - обмежувати
high-speed spindle - швидкісний вал
gear - підшипники
multigrade oil - мастила широкого спектру використання
additive - домішка
detergent - дезінфекційний засіб
fine carbon particles - дрібні часточки вуглецю
to suspend - зависати
friction - тертя
wear - зношування
axle - вісь
to prevent the seizing - перешкоджати тертю
thickening agent - загущувач

soap - мило
roofing felt - покрівельний матеріал
electrical insulation – електроізоляція

Exercise 2. *Read and translate the text. Make the plan of the text.*

Oil Products and Their Uses

Gases. Gaseous refinery products include hydrogen, fuel gas, ethane and propane or LPG. Most of the hydrogen is consumed in refinery desulfurization facilities; small quantities may be delivered to the refinery fuel system. Refinery fuel gas usually has a heating value similar to natural gas and is consumed in plant operations. Periodic variability in heating value makes it unsuitable for delivery to consumer gas systems. Ethane may be recovered from the refinery fuel system for use as a petrochemical feedstock. Liquefied petroleum gas, or LPG, is a convenient, portable fuel for domestic heating and cooking or light industrial use.

Kerosene. Though its use as an illuminant has greatly diminished, kerosene is still used extensively throughout the world in cooking and space heating and is the primary fuel for modem jet engines. When burned as a domestic fuel, kerosene must produce a flame free of smoke and odour. Standard laboratory procedures test these properties by burning the oil in special lamps. All kerosene fuels must satisfy minimum flash point specifications (49°C) to limit fire hazard in storage and handling. Jet fuels must bum cleanly and remain fluid and free from wax particles at the low temperatures experienced in high-altitude flight. The conventional freeze-point specification for commercial jet fuel is 50°C. The fuel must also be free of any suspended water particles that might cause blockage of the fuel system with ice particles.

Diesel oil. The principal end use of gas oil is as diesel fuel for powering automobile, bus, and railway engines. In a diesel engine, combustion is induced by the heat of compression of the air in the cylinder under compression. Detonation, which leads to harmful knocking in a gasoline engine, is a necessity for the diesel engine. A good diesel fuel starts to bum at several locations within the cylinder after the fuel is injected.

High-quality diesel fuels have cetane ratings of about 50, giving the same combustion characteristics as a 50-50 mixture of standard fuels. The large, slower engines in ships and stationary power plants can tolerate even heavier diesel oils. The more viscous marine diesel oils are heated to permit easy pumping and to give the correct viscosity at the fuel injectors

for good combustion.

Fuel oils. Furnace oil consists largely of residues from crude oil refining. These are blended with other suitable gas oil fractions in order to achieve the viscosity required for convenient handling. As a residue product, fuel oil is the only refined product of significant quantity that commands a market price lower than the cost of crude oil. Because the sulfur contained in the crude oil is concentrated in the residue material, fuel oil sulfur levels naturally vary from than 1 to as much as 6 percent. However, residual fuels may contain large quantities of heavy metals such as nickel and vanadium; this produce ash upon burning and can foul burner systems. Such contaminants are not easily removed and usually lead to lower market prices for fuel oils with high metal contents. In order to reduce air pollution, most industrialized countries now restrict the sulfur content of fuel oils. Such regulation has to the construction of residual desulfurization units or cockers in refineries that produce these fuels.

Lubricating oils. Viscosity is the basic property by which lubricating oils are classified. The requirements vary from very thin oil needed for the high-speed spindles of textile machinery to the viscous, tacky materials applied to open gears or wire ropes. Between these extremes is a wide range of products with special characteristics. Automotive oils represent the largest segment in the market.

Recently multigrade oils have been developed using long-chain polymers. Such oil performs well under cold starting conditions in winter yet will lubricate under high-temperature running conditions in the summer as well. Other additives that improve the performance of lubricating oils are antioxidants and detergents, which maintain engine cleanliness and keep fine carbon particles suspended in the circulating oil.

Gear oils and greases. In gear lubrication the oil separates metal surfaces, reducing friction and wear. Extreme pressures develop in some gears, notably those in the rear axles of cars, and special additives must be employed to prevent the seizing of the metal surfaces. These oils contain sulfur compounds that form a resistant film on the surfaces, preventing actual metal-to-metal contact. Greases are lubricating oils to which thickening agents are added. Soaps of aluminum, calcium, lithium, and sodium are commonly used, while non-soap thickeners such as carbon, silica, and polyethylene also are employed for special purposes.

Other petroleum products. Highly purified naphthas are used for solvents in paints, cosmetics, commercial dry cleaning, and industrial product manufacture. Petroleum waxes are employed in paper manufacture and foodstuffs. Asphaltic bitumen is widely used for the construction of

roads and airfields. Specialized applications of bitumen also include the manufacture of roofing felts, waterproof papers, pipeline coatings, and electrical insulation. Carbon black is manufactured by decomposing liquid hydrocarbon fractions. It is compounded with rubber in tire manufacture and is a constituent of printing inks and lacquers.

Exercise 3. *Answer the following questions.*

1. How is kerosene used nowadays? 2. Kerosene must produce a flame free of smoke and odour, must not it? 3. What characteristics must jet fuel have? 4. What is the best diesel fuel made of? 5. What engines can tolerate even heavy diesel oils? 6. Why are the more viscous marine diesel oils heated? 7. What can you tell about the standards for diesel fuel quality? 8. Does furnace oil consist of residues from crude oil refining? 9. What may residual fuels contain? 10. What is done to reduce air pollution? 11. How do requirements for viscosity vary? 12. What can you tell about automotive oils? 13. How do lubricating properties depend on temperature? 14. What quality of lubricating oils maintains engine cleanliness? 15. What are greases?

Exercise 4. *Match words with their definitions.*

1. Kerosene	A) the white, grey or black gas that is produced by burning something;
2. Residue	B) a thick substance made of oils or fats, used for making things such as candles for polishing things;
3. Friction	C) in natural condition;
4. Wear	D) a type of oil that is burned for heat and light;
5. Odour	E) very small piece of something;
6. Power plant	F) damage caused when something is used over a long period;
7. Crude	G) a thick oily substance that is put on the moving parts of something to make it run smoothly;
8. Fuel	H) a substance that remains after something else has disappeared or being removed;
9. Grease	I) equipment in a car or other vehicle that turns power from the engine into movement;
10 Particle	J) a substance which can be burned to produce heat or power;
11. Gear	K) a liquid or power containing soap, used for washing clothes machines;
12. Smoke	L) when one surface rubs against another;
13. Wax	
14. Detergent	

	M) a smell, especially an unpleasant one; N) a building where electricity is made.

Exercise 5. *Fill in the gaps using the list of words or word combinations below.*

Residues, jet fuels, lubrication, jet engines, friction, diesel fuel, greases, sulfur, antioxidants, kerosene, wax, viscosity

1. ... is still used throughout the world in cooking and space heating and is the fuel for modem____ . 2. _____ must bum cleanly and remain fluid and free from _____ particles at the low temperatures. 3. The principal end use of gas oil is as _____ for powering automobile, truck, bus, and railway engines. Furnace oil consists of _____ from crude oil refining. 5. In order to reduce air pollution, most industrialized countries restrict the _____ content of fuel oils. 6. _____ is the basic property by which lubricating oils are classified. 7. Other additives that improve the performance of lubricating oils are _____ and detergents. 8. In gear _____ the oil separates metal surfaces, reducing _____ and wear. 9. _____ are lubricating oils to which thickening agents are added.

Exercise *6*. *Complete the following sentences.*

1. Kerosene is still used extensively throughout the world in ... . 2. When burned as a domestic fuel, kerosene must produce a flame free of ... 3. The principal end use of gas oil is as diesel fuel for powering ... . 4. Furnace oil consists largely of ... . 5. Residual fuels may contain large quantities of... 6. Viscosity is the basic property by which ... . 7. Greases are lubricating oils to which ... . 8. In gear lubrication the oil separates ... .

Exercise 7. *Decide whether the following statements are true (T) or false (F) in relation to the information in the text.*

1. Kerosene is still used extensively as an illuminant. 2. All kerosene fuels must satisfy minimum flash point specifications (49° C) to limit fire hazard in storage and handling. 3. Furnace oil consists mainly of residues from crude oil refining. 4. Fuel oils are used for powering automobile, truck, bus and railway engines. 5. In order to reduce air pollution, many countries reduce the sulfur content of fuel oils. 6. Nowadays the suitability of petroleum fractions for use as lubricants depends on the crude oils from which they are derived. 7. Gear oils separate metal surfaces and reduce friction and wear.

Exercise *8*. *Circle the correct verb form to fill in the gaps in the sentences.*

1. Standard laboratory procedures ... these properties by burning the oil in special lamps.
   a) tests b) test c) are testing
2. Detonation ... to harmful knocking in a gasoline engine.
   a) leads b) is leading c) lead
3. Oils ... to permit easy pumping.
   a) heat b) are heated c) is heated
4. Most industrialized countries now ... the sulfur content of fuel oils.
   a) is restricting b) restricted c) restrict

Exercise 9. *Rewrite the following sentences in Passive Voice.*

1. Straight-chain hydrocarbons make the best diesel fuel. 2. We use kerosene extensively throughout the world in cooking and space heating. 3. We heat the more viscous marine diesel oils to permit easy pumping. 4. Industrialized countries restrict the sulfur content of fuel oils. 5. The Society of Automotive Engineers defined specifications for automobile oils. 6. In gear lubrication the oil separates metal surfaces. 7. We employ nonsoap thickeners for special purposes.

Exercise 10. *Put special questions to the underlined words.*

1. Kerosene is used <u>in cooking and space heating</u>. 2. In gears lubrication <u>the oil</u> separates metal surfaces. 3. <u>Residual fuels</u> may contain large quantities of heavy metals. 4. Kerosene must produce a flame <u>free of smoke and odour</u>. 5. <u>Automotive</u> oils represent the largest segment in the market.

Exercise 11. *Choose the correct word to complete each sentence. Define their part of speech. You can change the words slightly,*

lubrication - lubricant - lubricating - lubricate

1. Such an oil _____ under high-temperature running conditions in the summer. 2. Earlier the suitability of petroleum fractions for use as _____ depended entirely on the crude oil. 3. Greases are _____ oils to which thickening agents are added. 4. The purpose of engine _____ is to prevent metal-to-metal contact between parts.

viscous – viscosity

1. _____ is the basic property by which lubricating oils are classified 2. More marine diesel oils are heated to permit easy pumping and to give the correct _____ at the fuel injectors for good combustion.

contaminant - contamination - to contaminate

1. Chemical waste had _____ the water supply. 2. Such ____ are not easily removed and usually lead to lower market prices for fuel oils. 3. In order to reduce _____ many countries restrict the sulfur content of fuel oils.

Exercise 12. *Look back in the text and find words that have a similar meaning to the given words.*

Up-to-date, smell, danger, contamination, to divide, to lower, remainder, to use, to allow, to produce.

Exercise 13. *Use the information in the text to complete the dialogue in your own words.*

A: What oil products do you know?

B: . . . .

A: Where is kerosene used nowadays?

B: . . . .

A: What are the main characteristics of kerosene?

B:. . . .

A: . . . ?

B: Diesel fuel is used for powering automobile, truck, bus and railway engines.

A: . . . ?

B: It starts to burn at several locations within the cylinder after the fuel is injected.

A: What is the purpose of oil in gear lubrication?

B: . . . .

A: . . . ?

B: These oils contain sulfur compounds.

Exercise 14. *Translate into English.*

1. Гас все ще широко використовується при приготуванні їжі, і є основним паливом для сучасних реактивних двигунів. 2. Реактивні палива повинні згоряти чисто і залишати рідину без часточок воску при низьких температурах. 3. Військові реактивні палива спеціального призначення мають навіть більше суворих вимог. 4. Паливне масло складається з великої кількості залишків від очищення нафти. 5. Природній газ здатний зменшувати об’єм при його низькотемпературному зрідженні. 6. Продуктами повного згоряння метану є нешкідливі речовини - вуглекислий газ і вода. 7. Щільність

природнього газу в тисячу раз нижче щільності бензину.

Exercise 15. *Translate the text in written form and put ten questions to it.*

Petrochemicals

Petrochemicals are chemicals derived from petroleum, that is, oil and gas formed from the decayed remains of marine plants and animals millions of years ago. Coal was formed from land-based organisms and is a hard, brittle rock composed mainly of carbon, whereas oil is a liquid. Coal, oil, and gas are known as fossil fuels. Oil and gas contain mainly carbon and hydrogen, and so they are called hydrocarbons. Carbon is twelve times heavier than hydrogen and one carbon atom combines with up to four atoms of hydrogen. As more carbon atoms combine together and with hydrogen, the resulting compounds become heavier. The lightest, simplest hydrocarbon is methane, which has the chemical formula CH_4. Heavier gases are ethane (C_2H_6), propane (C_3H_8), and butane (C_4H_{10}). The next compound in the series, pentane (C_5H_{12}), is a volatile liquid at room temperature.

A simple chemical with a double carbon bond is the gas ethylene (C_2H_4) which is produced by steam cracking in the refinery. It is used in chemical plants to make polyethylene by joining the ethylene molecules together under pressure in the presence of a catalyst. It is the most widely used plastic, mainly produced in sheets for packaging. The names of many other useful polymers begin with the prefix 'poly'. Polyester, polystyrene, polyamide (nylon), polycarbonate, and polyvinyl chloride are examples. Many of these polymers can be extruded to produce pipes and fibers. The fibers can be made into fabrics. Plastics can be moulded into complex shapes or made with air bubbles to produce foam. Certain polymers combined with carbon black are substitute for natural rubber and are used to make car tyres.

Synthetic resins are petrochemical liquids that are capable of hardening. They are used for paints, adhesives, and varnishes. Epoxy resin is used with a hardener in conjunction with a strong fiber such as glass or carbon. Such materials are stiff, strong, and light. They are replacing aluminum as a structural material in aircraft. The properties of petrochemicals are superior and more consistent than natural materials. They are also cheap to produce and relatively expensive to recycle so they create problems in disposal and pollution.

Exercise 16. *Choose the products made of oil or natural gas from the list and make a short presentation about its production and use.*

Petrol, plastic bags, propane, some chemicals in detergents, asphalt, some chemicals in fertilizers, tyres, rubber, medications, cosmetics, paints, clothes.

Exercise 17. *A) Choose the correct definition for each word.*

1. carbon black - a) a fuel; b) a colouring;
2. in prehistoric times - a) a very long time ago; b) recently;
3. plentiful - a) dangerous; b) easy to find;
4. inexpensive - a) cheap; b) hard to get;
5. crayon - a) a type of tyre; b) a drawing tool;
6. by-product - a) an extra, unneeded product; b) a flammable product;
7. hydrocarbon molecule - a) petrochemicals; b) pieces of hydrogen and carbon;
8. familiar - a) known by many people; b) useful;
9. synthetic - a) manmade; b) natural.

B) Read the text and check whether your choises are correct.

Before oil and gas were freely available, people made everyday things from natural materials. Clothes were made from cotton, wool, and leather. Containers, for example bottles and cups, were made from metal, glass, and clay. Paints and cosmetics were made from plants and minerals. One example of a natural product is carbon black. It's a colouring used in ink for writing and drawing and for paint. It is made by burning wood, oil, or other natural materials. It was discovered in prehistoric times, and it's commonly used today.

The first petrochemical factory was built in 1872, and it made carbon black from natural gas. Carbon black wasn't a new product, but using a factory was a new way of making it. It became possible to make large amounts of it cheaply because natural gas was plentiful and inexpensive. At that time, carbon black was used to make ink, paint, and crayons. It is now used mostly to make car tyres.

In the early 1900, the petrochemical business began to grow. There were a lot of oil refineries, and they created chemical by-products. Oil companies wanted to find ways to use these chemicals. Soon scientists and engineers learned to change the hydrocarbon molecules in coal, petroleum, and refinery by-products. From the 1920s to the 1940s, familiar man-made products like nylon, polystyrene, and polyvinyl chloride were developed. Synthetic dyes, paints, and medicines were invented.

Today, petrochemical products are everywhere. They are very

useful, but they also have some problems. People throw away a lot of plastic products because they are inexpensive. One problem with plastics is that generally they do not rot or break up like natural materials. Plastic bags are already polluting oceans and killing wildlife. They cannot easily be remelted and reused. Scientists and petrochemical manufacturers continue their work to develop safe and useful products.

Exercise 18. *Develop the ideas below.*

1. Gas is more difficult to store than oil mainly because its volume at normal temperature and pressure is 1.000 times that of oil for the same amount of energy content. In small densely populated countries like the United Kingdom, when coal was the main source of fuel in the early twentieth century, an infrastructure was built to distribute gas from coal throughout the country using a pipeline system from the gas plants to homes in major towns and cities.

2. Where pipeline systems are not available, gas is distributed for domestic use in pressurized containers as propane or butane, known as liquefied petroleum gas (LPG). The liquefied gas is stored in cylindrical or spherical containers at refineries and terminals and can be transported by road to residential storage tanks or in smaller exchangeable cylinders.

3. Russia has the largest reserves of natural gas in the world and transports most of its gas by pipeline. It supplies one quarter of Europe's gas requirements and 80% of this is by pipeline through Ukraine. The risk to supplies was highlighted by a dispute between Ukraine and Russia in 2009 which affected supplies to Ukraine and Europe.

4. The top producers of petrochemicals are countries in North America and Europe. But this is changing. Now many countries in Asia and the Middle East are building new petrochemical plants, and petrochemical production is going up fast in these countries.

5. Oil and gas companies are planning to increase world gas production by 50% before 2030. Big gas producers like Russia, Saudi Arabia, Qatar, Iran, and the UAE are increasing their production fast. Gas production in Africa, Europe. Asia and the Americas is growing too.