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Part I

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Draftsmen
E.V. Shvagrukova, G.P. Pozdeeva, Yu. V. Kolbysheva

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МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ
Федеральное государственное автономное образовательное учреждение высшего образования
**«НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»**

ПРОФЕССИОНАЛЬНЫЙ ИНОСТРАННЫЙ ЯЗЫК (АНГЛИЙСКИЙ)

Часть 1

*Рекомендовано в качестве учебного пособия
Редакционно-издательским советом
Томского политехнического университета*

Составители
Е. В. Швагрукова, Г.П. Поздеева, Ю.В. Колбышева

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Настоящее учебное пособие используется для самостоятельной работы студентов по закреплению и усвоению грамматического и лексического материала, состоящего из общетехнической, общенаучной и профессиональной лексики; развития умений профессионально ориентированной письменной речи; для обучения основным видам чтения, а также для контроля понимания прочитанного и умения переводить профессионально ориентированные тексты. Кроме того, данный УМК включает рекомендации по овладению произносительной стороной речи и выполнению упражнений, вызывающих затруднения. В приложениях рассматриваются особенности употребления основных языковых явлений.

Пособие является первой частью учебно-методического комплекса для студентов заочного отделения специальностей 21.03.01 «Нефтегазовое дело», 21.05.02 «Прикладная геология», 21.05.03 «Технологии геологической разведки» ИШПР НИ ТПУ.

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ББК Ш143.21-923

Рецензенты

Кандидат филологических наук,
доцент кафедры истории русской литературы XX века НИ ТГУ
А.Б. Стрельникова

Кандидат филологических наук,
доцент кафедры славянской филологии и межкультурной коммуникации ТГПУ
Н.В. Дубровская

ISBN 978-5-4387-0860-5 (ч. 1)
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INTRODUCTION

The modern community requires the graduate of an educational institution to be successful in his professional activity and could make a career independently, work in competitive environment at national and international levels, thereby, contributing to prosperous well-being of the society.

The modern conditions of professional activity which are the result of rapid development of global business determine an increasingly growing interest to learning foreign languages and, especially, English as a means of international communication. The success of cross-cultural relationships depends on the ability of people to adequately understand each other, interact and cooperate.

ESP Correspondence Course is organized around a subject–matter core and is appropriate to the needs of specific groups of students. The main purpose is language proficiency development for 3d-4th year correspondent students majoring in petroleum engineering.

The manual develops the necessary practical skills to support communication in both oral and written forms of the language required by the conditions of professional interaction.

The course consists of two modules, four units, two self-study parts, two key to self-study sections and a variety of supplementary material. The course may require classroom work or can be partially or entirely worked through at home by individual students.

The modules correspond to the basic fields of professional expertise in petroleum engineering and are developed to train the skills relevant for the successful accomplishment of the Progress Test tasks.

Each module focuses on a core of useful language related to the topics of professional interest with which the students need to be familiar. The suggested succession of modules is predetermined by the nature of language mastering ability. It provides gradual increase in complexity and difficulty of studied material. In accordance with this pedagogical principle, profound knowledge of basic language units (vocabulary) and their combinability (grammar) makes it possible to recognize them in a natural written speech (reading). Subsequently, speaking and writing skills can be further developed as productive aspects of language usage.

The units follow the same basic structure which includes **Lead-in sections**, briefly introducing the basic subject-matter, and **Practice sections**, consisting of a set of exercises to train and develop the necessary skills and language aspect usage. The phonetic, vocabulary, grammar, reading and writing practice is provided. **Assessment sections**, reinforcing students' knowledge of the topics, vocabulary and structures presented in the previous units or the entire module, include Progress Tests which are aimed at getting feedback and assessing students' progress throughout the course.

The course is accompanied by easy to comprehend and operate **Appendixes** which can be used as Vocabulary, Grammar and Writing reference materials.

Course Outline

Содержание программы и цели обучения Профессиональному иностранному языку (английскому)

Целью дисциплины «Профессиональный иностранный язык (английский)» является совершенствование иноязычной коммуникативной компетенции студентов, необходимой для осуществления профессиональной деятельности и позволяющей им использовать иностранный язык в профессиональной сфере.

В результате освоения дисциплины «Профессиональный иностранный язык (английский)» студенты должны уметь:

В области говорения:

- строить небольшие монологические высказывания по профессиональной тематике в пределах изученных тем с опорой на картинки, схемы или оригинальные тексты.

В области чтения:

- понимать короткие адаптированные тексты, отражающие ситуации связанные с профессиональной деятельностью;
- извлекать необходимую информацию из аутентичных текстов общетехнической и профессиональной направленности;

В области письма:

- писать короткое сообщение по вопросам, связанным с описанием отдельных фактов, событий;
- составить аннотацию текста по профессиональной тематике;

Наряду с практической целью обучения, данный курс имеет образовательные и воспитательные цели. Достижение образовательных целей осуществляется в аспекте гуманизации технического образования и означает расширение кругозора студентов, повышение уровня общей культуры мышления, общения и речи.

Реализация воспитательного потенциала курса проявляется в готовности специалистов содействовать налаживанию межкультурных и научных связей, представлять свою страну на международных конференциях и симпозиумах, относиться с уважением к духовным ценностям других стран и представителей иной языковой культуры.

При обучении студентов английскому языку ставятся следующие **задачи**:

- формирование лексико-грамматических навыков и развитие умений в опосредованных видах речевой деятельности (далее ВРД);
- планомерное и целенаправленное развитие умений использования стратегий автономной учебно-познавательной деятельности;
- формирование позитивного отношения и интереса к культуре страны изучаемого языка;

- стимулирование познавательной активности студентов и мотивации к изучению аспектов использования иностранного языка в профессиональном общении.

Цели и задачи дисциплины достигаются на практических занятиях, в процессе самостоятельной работы студентов и консультаций, в форме электронного обучения и он-лайн. При обучении используются как традиционные, так и современные методы и приемы обучения.

Содержание обучения определяется спецификой курса и включает определенный набор лексических единиц, грамматических тем социолингвистических и стратегических навыков и умений в опосредованных видах речевой деятельности, по тематике в сфере повседневно-бытового и профессионального общения.

ФОНЕТИЧЕСКИЙ МИНИМУМ. Звуковой строй английского языка; особенности произношения английских гласных и согласных, ударение, особенности интонации английского предложения на материале изучаемых лексических ядиниц и грамматических явлений, встречающихся в рассматриваемых текстах.

ЛЕКСИЧЕСКИЙ МИНИМУМ. За полный курс обучения студент приобретает словарный запас в 1000–1500 лексических единиц (слов и словосочетаний).

Данный объем лексических единиц является основой для расширения потенциального словарного запаса студентов, и поэтому программа предусматривает усвоение наиболее употребительных словообразовательных средств английского языка: префиксов, основных суффиксов имен существительных, прилагательных, наречий, глаголов. В словарный запас включаются также фразеологические сочетания, наиболее употребительные синонимы, антонимы, встречающиеся в английских научных и технических текстах.

ГРАММАТИЧЕСКИЙ МИНИМУМ. В процессе обучения студент усваивает сложные грамматические формы и структуры английского языка, характерные для профессиональной сферы общения и технических текстов.

Страдательный залог. Способы перевода. Особенности употребления. Условные предложения в английском языкею Типы, перевод и особенности употребления.

Формирование вышеперечисленных навыков является необходимой основой развития целого ряда умений, определяющих уровень иноязычной компетенции, достаточной для опосредованного общения.

УМЕНИЯ ГОВОРЕНИЯ

- вести устный обмен информацией на английском языке в повседневных ситуациях на элементарном уровне;

- отвечать на вопросы, обмениваться мнениями и информацией в пределах изученных тем профессиональной направленности: Geology, Rocks and minerals, Properties of minerals, Mining engineering, Prospecting and exploration, Oil formation.

УМЕНИЯ ЧТЕНИЯ

- понимать короткие адаптированные тексты, имеющие профессиональную тематику;
- извлекать необходимую информацию из аутентичных текстов общетехнической и общенаучной направленности из учебника и специализированных изданий;
- понимать логическую структуру текста и последовательность событий, изложенных в них;
- выбирать вид чтения в соответствии с поставленной целью (ознакомительное, просмотровое, поисковое и др.) при работе с текстами.

УМЕНИЯ ПИСЬМЕННОЙ РЕЧИ

- писать короткое сообщение по ключевым словам слайда, связанным с описанием отдельных фактов, событий;
- писать грамматически и лексически правильное сообщение, содержащее ответ на поставленный вопрос;
- написать аннотацию текста по профессиональной тематике.

Course Structure and Progress Test Requirements

Структура курса

Структура курса «Профессиональный иностранный язык (английский)» разрабатывается с учетом дистанционного и проблемно-ориентированных методов и принципа модульной организации процесса обучения и представляет собой логически взаимосвязанные модули. Каждый из модулей имеет единую структуру и состоит из уроков, заданий для самостоятельного выполнения и проверки, а также тестовых контрольных работ.

В соответствии с действующими учебными планами на полный курс обучения «Профессиональному иностранному языку (английскому)» для заочных отделений вузов неязыковых специальностей отводится не менее 24 часов обязательных аудиторных занятий, 264 часа самостоятельной работы и консультации из расчета один час на каждого студента. За курс обучения студент выполняет четыре контрольные работы, сдает четыре зачета.

Распределение учебных часов.

3 курс: 12 часов аудиторных занятий, 132 часа самостоятельной работы. Студент выполняет две контрольные работы и сдает зачет в конце пятого и шестого семестров.

4 курс: 12 часов аудиторных занятий, 132 часа самостоятельной работы. Студент выполняет четыре контрольные работы, сдает зачеты по окончании седьмого и восьмого семестров обучения.

Требования на зачете

Программа данного курса предусматривает проведение рубежного контроля знаний, навыков и умений. Целью контроля является оценка качества языковой подготовки студентов по изучаемой учебной дисциплине.

Рубежный контроль (зачет) позволяет определить качество усвоения студентами учебного материала по разделам (подтемам) модуля. Проводится в V, VI,VII и VIII семестрах.

Зачет. К зачету допускаются студенты, представившие контрольную работу, включающую задания по чтению, лексике и грамматике, выполняемые в письменной форме.

Для получения зачета студент должен уметь:

а) прочитать со словарем текст на английском языке, содержащий изученный грамматический материал. Форма проверки – письменный или устный перевод. Норма перевода – 600–800 печатных знаков в час письменно или 1000–1200 печатных знаков в час устно;

б) беседа по одной из пройденных за семестр разговорных тем.

Выполнение и оформление контрольных работ

Количество контрольных заданий, выполняемых на каждом курсе, устанавливается учебным планом университета. Каждая контрольная работа включает 5 вариантов. Студент должен выполнить один из 5 вариантов в соответствии с последними цифрами номера зачётной книжки:

1,2 – вариант № 1;
3,4 – вариант № 2;
5,6 – вариант № 3;
7,8 – вариант № 4;
9,0 – вариант № 5.

Контрольная работа должна быть выполнена на листах формата А4 печатным способом, 14 шрифтом, Times New Roman, 1,5 интервал, параметры страницы должны соответствовать ГОСТу Р 6.30-2003 (верхнее, нижнее, левое поле 20 мм, правое – 10 мм). Титульный лист должен содержать: полное наименование образовательного учреждения, вид работы, название дисциплины, фамилию, имя, отчество студента, курс, номер группы, номер зачётной книжки, номер контрольной работы.

Студенты заочного отделения изучают «Профессиональный иностранный язык (английский)» 2 года – на третьем и четвертом курсе, т. е. 4 семестра. Итогом обучения является зачет на 4-м курсе (8 семестр).

Зачет на третьем курсе предполагает выполнение контрольных работ № 1–2 (5 семестр – контрольная работа № 1 (TEST 1); 6 семестр – контрольная работа № 2 (TEST 2).

UNIT 1

WHAT IS GEOLOGY?

LEAD-IN

Answer the following questions:

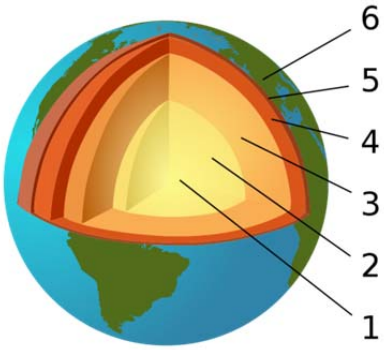
What does the word "geology" mean?

What does geology deal with?

Match the English words with the pictures:

a

b



c

d

1. Geology tools
2. The Earth's layered structure
3. Rocks and minerals
4. A geological map

I. Read and remember the list of words associated with Geology.

1)	crust (Earth)	– кора (земная)
2)	event	– ход событий
3)	force (s)	– сила
4)	evidence	– доказательство, подтверждение
5)	to interpret	– интерпретировать; понимать
6)	to affect	– действовать
7)	endogenous	– эндогенный
8)	exogenous	– экзогенный
9)	to originate	– происходить, возникать

10) volcanic activity – вулканическая активность
11) earthquake – землетрясение
12) destructive – разрушительный
13) effect – следствие
14) weathering – выветривание
15) erosion – эрозия
16) transport (of rock material) – перенос
17) to pertain to – относиться, иметь отношение (to – к чему-л.)
18) to be concerned with – связанный с чем-л.
19) to draw on – использовать
20) to decipher – расшифровывать, понимать

II. Read the following words and remember their pronunciation.

[ə:] s**ur**face, **ear**th, f**ir**st
[o] ge**o**logy, carb**o**nic, **o**xygen,
[i] h**i**story, l**i**ving, cons**i**st
[ai] s**i**des, k**i**nds, l**i**mestone
[o:] transf**or**m, **or**ganism, f**or**med, s**our**ce

III. Pay attention to the stress in the following words.

ge´ology	phe´nomena	de´velop
pro´ceed	partici´pation	ex´plore
e´vent	accumu´lation	´layer
clima´tology	´saturate	´knowledge

READING

IV. Read the text and match the parts of the sentences.

GEOLOGY

The word Geology comes from the Greek language and means “science or knowledge of the Earth”. Geology has to do with the nature and development of the Earth’s **crust**. **Events**, which happened hundreds of millions of years ago, have to be reconstructed from **evidence** that is available. Geology has been subdivided into several specialized disciplines. Classical geology **interprets** the events of the past in terms of processes, which occur at present.

The uppermost part of the crust is **affected** by two different kinds of **force**s. Firstly, there are e**ndogenous** forces that **originate** within the Earth. The crust is never completely at rest because of movements resulting from these endogenous forces. Everything is in motion. **Volcanic activity** and **earthquakes** are endogenous forces. The form of the Earth’s surface is the

result of a balance between the endogenous forces and exogenous forces that act at the Earth's surface. They are the **destructive effect**s of the **weathering**, **erosion** and **transport** of rock material. The principal agents of this process are water, wind and in the polar and mountain ranges, ice. Endogenous forces can result in the formation of new rocks (for example, in volcanoes), while exogenous forces are destructive and transportive. The study of the Earth's geological history is called stratigraphy.

Regional geology aims at the integration of all the geological information **pertaining to** a particular area and this is expressed in the form of geological map. Such maps are the essential basis of all kinds of practical geological work.

Applied geology is **concerned with** the practical use of geological knowledge (discovery of mineral resources, oil and water, etc.). The natural laws controlling geological processes have remained essentially the same for thousands of millions of years.

So geology is the study of the Earth's history and **draws on** all the technological resources of modern science in **deciphering** the record of the rocks as documents of Earth history. The present state of geology has been attained as a result of much work spread over many years and even now, views on the Earth's evolution and Man's ideas of his own development are far from complete.

Abridged from: Essential Geology. Student's book. TPUPublishing House. R.N.Abramova, O.V. Rozhkova, A. Yu. Falk. 2006.

1. The word geology comes	a) with the practical use of geological knowledge.
2. Geology has become subdivided	b) to a particular area.
3. We can draw	c) into several more specialized disciplines.
4. The upper part of the crust is affected	d) at the integration of the geological information.
5. The crust is constantly subjected	e) from the greek language.
6. Regional geology aims	f) by two different kinds of forces.
7. This information pertains	g) to vertical and horizontal movements.
8. Applied geology is concerned	h) on information from several disciplines.

V. Read the text and state, if the following statements are true (T) or false (F).

EARTH STRUCTURE

Advances in seismology, computer modeling, mineralogy and crystallography at high temperatures and pressures give insights into the internal composition and structure of the Earth.

Seismologists can use the arrival times of seismic waves in reverse to image the interior of the Earth. Early advances in this field showed the existence of a liquid outer core (where shear waves were not able to propagate) and a dense solid inner core.

These advances led to the development of a layered model of the Earth, with a crust and lithosphere on top, the mantle below (separated within itself by seismic discontinuities at 410 and 660 kilometers), and the outer core and inner core below that.

More recently, seismologists have been able to create detailed images of wave speeds inside the earth in the same way a doctor images a body in a CT scan. These images have led to a much more detailed view of the interior of the Earth, and have replaced the simplified layered model with a much more dynamic model.

Abridged from: https://en.wikipedia.org/wiki/Geology#Whole-Earth_structure

Statement	True/False (T/F)	
1. Modern geologists know the internal composition of the Earth.		
2. The Earth has only one core.		
3. The Earth consists of a crust and lithosphere, a mantel, and an inner core.		
4. Recently, seismologists have obtained detailed images of wave speeds inside the Earth.		
5. A layered model of the Earth was replaced by a dynamic one.		

VOCABULARY AND TERMINOLOGY

VI. Read the text GEOLOGY in detail. Study the following verbs. Fill in the gaps with one of the verbs from the list in the correct form and a suitable preposition. Use the Passive Voice where necessary.

come **from**	происходить
draw **on**	получить
be subdivided **into**	быть разделенным на
be affected **by**	находиться под воздействием ч.-л.

aim **at**	целить, метить во что-либо
pertain **to**	принадлежать, иметь отношение к
be concerned **with**	касаться, иметь отношение к

1. The word “geology” _____ the Greek language.
2. Geology _____ many different disciplines.
3. Many geological processes _____endogenous and exogenous forces.
4. Integration of all the geological information _____a particular area.
5. The Earth’s surface _____ many destructive forces, such as weathering, erosion, etc.
6. Applied geology _____ the practical use of geological knowledge.
7. Geology is the study of the Earth’s history and _____all the technological resources of modern science in deciphering the record of the rocks as documents of Earth history.

VII. Choose the correct variant a, b or c.

1. The surface of the Earth is formed by _____ .
   a) endogenous forces
   b) exogenous forces
   c) both
2. Geological maps _____ .
   a) show all geological information
   b) show geological information from particular areas
   c) show essential bases of all kinds of mining
3. At recent views on the Earth evolution and development of a man _____.
   a) have changed
   b) are not complete
   c) have not been determined
4. Geologists _____ .
   a) input different geological events
   b) establish history of the Earth
   c) both
5. Applied geology deals with _____ .
   a) practical application of geological science
   b) present day processes
   c) geological maps of different areas

VIII. Match the science (1–6) with the description of what it studies (a–f).

1) palaeontology	a) combines all the information from different fields of geological science and makes maps.
2) classical geology	b) is concerned with the study of earth's geological history on the basis of research of sedimentary rocks.
3) geology	c) deals with observations and classification of the remains in the rocks and thus constructs their evolution.
4) regional geology	d) studies the earth history and uses technology to decode the records of rocks.
5) stratigraphy	e) deals with practical application of geological knowledge.
6) applied geology	f) seeks to interpret the past events in terms of the processes which are at work at present.

IX. Read and remember the list of the words associated with GEOLOGICAL METHODS.

1)	identification	– определение, установление
2)	geological surveys	– геологические изыскания
3)	remote sensing	– дистанционная съемка
4)	geological mapping	– геологическое картирование
5)	folding	– смещение пласта без разрыва сплошности
6)	faulting	– складчатость
7)	igneous	– вулканический
8)	intrusion	– внедрение, магма
9)	airphoto interpretation	– расшифровка аэросъемки
10)	outcrop	– обнаженная порода
11)	creek	– залив
12)	fabric	– строение горной породы
13)	to rely on	– полагаться на
14)	to occur	– существовать
15)	to relate to	– относиться к

GEOLOGICAL METHODS

Geological methods rely on the identification of rocks and minerals and an understanding of the environment in which they formed. These surveys aim to find what rock types occur at or close to the surface and how these rock types are related to each other i. e. their boundaries, ages, and structure.

Based on known "environments for mineralisation" or models for mineralisation, regional geological surveys can be used to define smaller areas in which more detailed studies can be undertaken.

A geological survey can be undertaken using a number of methods depending on the size of a region and the amount of information that is required.

Remote Sensing – some geological mapping can be done using satellite remote sensing methods. While most of these methods rely on geophysical rather than pure geological data, the use of this method can give broad scale views of surface geological structures such as folding, faulting, igneous intrusions, etc.

Airphoto interpretation – this can give a broad overview of the geological relationships of an area with no detailed knowledge of the mineral composition or fabric of the rocks.

Outcrop surveys – this is normally achieved by geologists driving along roads and walking traverses along creeks and rivers mapping the outcropping rock types. This can give a regional view of the rock types and their mineral content and fabric, but often no clear understanding of the relationships between rock layers (unless outcrop is exceptional).

Geology interpretation surveys – these are more detailed outcrop surveys where geological boundaries are established and interpreted in a small area.

Abridged from: http://www.australianminesatlas.gov.au/education/down_under/exploration/geological.html

X. Read the sentences about GEOLOGICAL METHODS and state, if they are true (T) or false (F).

Statement		True/False (T/F)	
1.	Geologists use a wide variety of geological methods in their work.		
2.	The aim of all geological surveys is to explore oil fields.		
3.	Regional geological surveys deal with vast territories all over the world.		
4.	Remote sensing methods are performed with the use of sattelites.		
5.	Airphoto interpretation gives the detailed knowledge of the mineral composition or fabrics of the rocks.		

Statement	True/False (T/F)	
6. Outcrop surveys give only a broad overview of the geological relationships of an area.		
7. Geology interpretation surveys are the most detailed survey, where a small area is analysed.		

GRAMMAR

The Passive voice

We form the Passive voice with the verb **to be** and the P**ast Participle** of the main verb.

to be + Past Participle (pp)

We use the Passive voice:

1. When the person who carries out the action (the agent) is unknown, unimportant or obvious from the context. ***E.g.*** *My car* ***was stolen*** *last night.* (unknown agent) *The plants* ***are watered*** *every evening.* (unimportant agent) *The house* ***was burgled****.* (*by a burglar* – obvious agent)
2. When the action itself is more important than the agent, especially in news headlines, newspaper articles, formal notices, instructions, advertisements, processes, etc. ***E.g.*** *The new wing of the hospital* ***was opened*** *by the President yesterday morning.* (formal notices) *The seeds* ***are planted*** *months before the year's wheat is harvested.* (processes)
3. **When we want to make statements more polite or formal and we do not want to say who or what is to blame.** ***E.g.*** *My new CD player* ***is broken****. (*more polite than *You've broken my new CD player.)*

(For more details you may see Grammar Reference p. 169)

XI. Complete the following passive voice sentences in the tenses suggested.

1. This picture (always admire). – *Present Simple*
2. The Tower of London (formerly use) as a prison. – *Past Simple*
3. This play (forget) in a few years' time. – *Future Simple*
4. English (speak) all over the world. – *Present Simple*
5. Any questions (ask) about me? – *Past Simple*
6. The matter (discuss) tomorrow. – *Future Simple*

7. Milk (use) for making butter and cheese. – *Present Simple*
8. The bridge (build) last year. – *Past Simple*
9. The book (finish) next month? – *Future Simple*
10. Your question (answer)? – *Present Simple*
11. I (punish) for something I didn't do. – *Past Simple*
12. What (do) about this? – *Future Simple*

XII. Change the forms of the verbs in the sentences from the active into the passive voice. Translate the sentences into Russian.
Example: *Someone is interviewing Dr Jonhson at the moment. –*
Dr Jonhson is being interviewed at the moment.

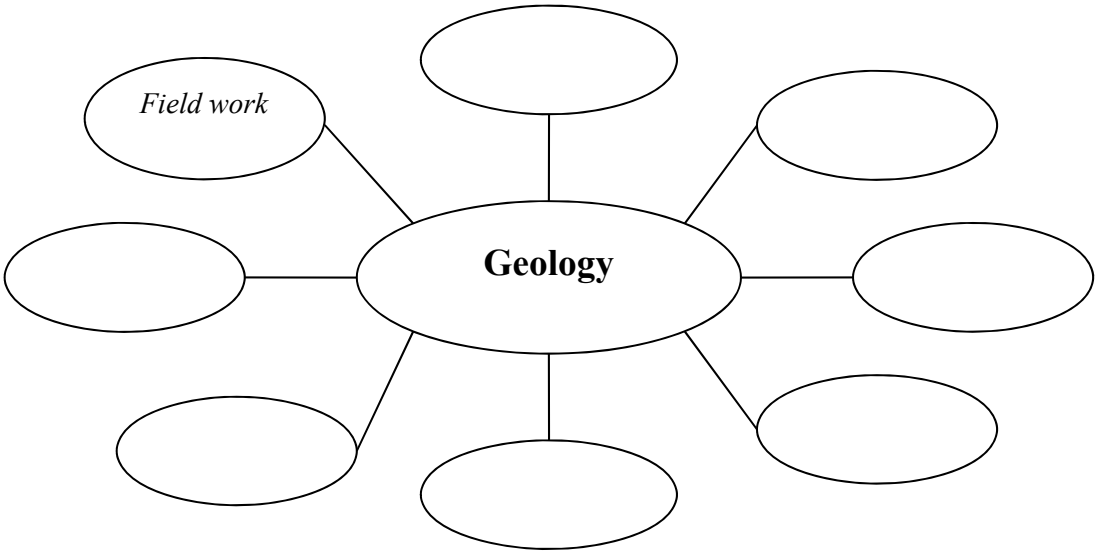
1. You mustn't use this machine after 5:30 p. m.
2. We had warned him the day before not to go too near the canal.
3. They are mending your shoes at the moment.
4. Someone will drive your car to Edinburgh on Tuesday.
5. They don't allow smoking at this restaurant.
6. You should pay your bill before you leave the hotel.
7. I have told the children about the party.
8. About thirty million people are watching this programme.
9. We expect students not to talk during the examination.
10. You mustn't touch this button while the experiment is in progress.
11. Someone will blow a whistle if there's an emergency.
12. You should keep flowers in «a warm sunny place.

TRANSLATION

XIII. Search the texts of Unit 1 for 10 sentences in the Passive voice, write them down and translate into Russian.

SPEAKING
XIV. **Answer the questions concerned with GEOLOGY.**
1. What is classical geology aimed at?
2. What forces affect the Earth’s crust?
3. How do endogenous forces affect the crust?
4. What are the obvious effects of the exogenous forces?
5. What does stratigraphy deal with?
6. What is regional geology aimed at?
7. What does applied geology deal with?

XV. Fill in the spidergram with the words associated with Geology and explain your associations.



Example: *Geologists have to do a lot of field work under severe conditions.*

XVI. Describe the pictures in 10 sentences.

a

b

Example: *Geologists conduct investigations on site.*

WRITING

XVII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176)

FOUNDERS OF GEOLOGY

In the late 1700's Scotland became the home of practical geology. When we look at a geological map of the world it is not difficult to see why Scotland, within its 49,000 square miles (80000 square km) possesses practically every geological structure and age of rock possible. The person regarded as the founder of modern geology is James Hutton (1726–1797), of Edinburgh. By studying the rocks where they outcropped (in the field, as geologists say),

he formulated theories about the past conditions that formed them. He visualized an abiding Earth on which forces of rock formation were balanced by forces of rock destruction. It was he who put the Neptunian theories to rest.

Another approach to practical geology is that of the experimental scientist. The pioneer in this field was Sir James Hall (1761–1832)-not the great 19th-century American geologist of the same name but another Scot from Edinburgh. Hall melted rock specimens in the furnace of an iron foundry and observed what was produced as they cooled. He also conducted experiments to stimulate the formation of various rock structures by compressing layers of clay. Most of these experiments were conducted after Hall's death, because he was dismissive of this experimental approach.

Abridged from: Dougal Dixon. The Practical Geologist. Aurum, US, 1992.

UNIT 2

ROCKS AND MINERALS

LEAD-IN

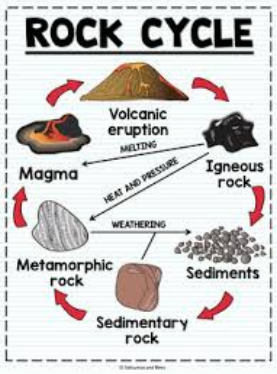
Answer the following questions:
What types of rocks do you know?
What minerals do you know?

Match the English words with the pictures:

a


b


c


d


1. Rock cycle
2. Sedimentary rocks
3. Igneous rocks
4. Metamorphic rocks

I. Read and remember the list of the words associated with Rocks and Minerals.

1)	rock	– горная порода
2)	aggregate	– сросток минералов
3)	igneous rocks	– вулканические (магматическая) породы
4)	sedimentary rocks	– осадочные породы
5)	metamorphic rocks	– метаморфические породы
6)	hydrothermal rocks	– гидротермальные породы
7)	solid state	– твердое состояние
8)	crystallization	– кристаллизация
9)	fluid	– жидкость

10) particle – включение
11) plutonic – глубинный, магматический
12) effusive – извергнутый
13) fine-grained – мелкозернистый
14) coarse-grained – крупнозернистый
15) lithification – окаменение, литификация
16) dissolved material – растворенное вещество
17) abundance – относительное количество, содержание
18) to melt – плавиться
19) to solidify – отвердевать
20) to cool – охлаждаться

II. Read the following words and remember their pronunciation.

[a:] p**a**rticle, m**a**rble, t**a**rget
[o] r**o**ck, diss**o**lved, s**o**lid
[i] **i**gneous, l**i**th**i**f**i**cation, sed**i**mentar**y**
[ai] crystall**i**zation, h**y**drothermal, solidif**y**
[o:] c**oa**rse, metam**o**rphic, f**or**med

III. Pay attention to the stress in the following words.

´aggregate	meta´morphic	lithifi´cation
´process	hydro´thermal	so´lidify
´igneous	crystalli´zation	ef´ficient
sedi´mentary	ef´fusive	´concentrate

READING

IV. Read the text and match the parts of the sentences.

ROCKS

A rock is an **aggregate** of minerals. Many different processes can form rocks. Some are formed from **melts** (igneous). Some are formed by **solidifying** sediments like sand or clay (sedimentary). Some are formed by re-crystallizing previously formed rocks in the solid state (metamorphic). And some are formed by crystallization from hot **aqueous fluids** (**hydrothermal**).

Rocks that are formed by crystallization of a melt are igneous. These may be formed at depth (intrusive or plutonic), or they may form on the surface (effusive or volcanic). In general, igneous rocks that cool rapidly (i. e. volcanic rocks) are very **fine-grained**; whereas rocks that cool slowly (i. e. plutonic rocks) are **coarse-grained**.

Rocks that are formed on the surface of the Earth by **solidification (lithification)** of **weathered or dissolved material** are sedimentary. These are generally classified by the size of the particles, although the compositions change systematically with particle size.

Rocks formed by recrystallization in the solid state are metamorphic. They may be **metamorphosed** from sedimentary, igneous, metamorphic, or hydrothermal rocks.

Rocks that are formed by crystallization from hot aqueous fluids are hydrothermal. These are commonly formed near intrusive igneous bodies. This is a very efficient way to concentrate the elements of low natural abundance, so many of the economically important ore minerals are formed this way.
Abridged from: Press Siever. Understanding Earth. Freema & Co, 1994.

1.	Many different processes	a) are igneous.
2.	Some rocks are formed	b) an aggregate of minerals.
3.	Rocks formed by crystallization of a melt	c) are coarse-grained.
4.	Igneous rocks that cool rapidly	d) from sedimentary, igneous, metamorphic, or hydrothermal rocks.
5.	Plutonic rocks	e) are formed this way.
6.	Rocks formed by lithification	f) by solidifying sediments like sand or clay.
7.	Rocks may be metamorphosed	g) near intrusive igneous body.
8.	Hydrothermal rocks are commonly formed	h) are very fine-grained.
9.	Many of the economically important ore minerals	i) can form rocks.
10.	A rock is	j) are sedimentary.

V. Read the text and state if the following statements are true (T) or false (F).

MINERAL PROPERTIES

Since most rocks contain minerals, some knowledge of minerals is necessary to identify rocks. Minerals are the fundamental building blocks of rock materials in the earth. They are defined as naturally occurring inorganic substances with a definite chemical composition and specific crystal structure. Over 4000 minerals have been identified in the Earth. There are over 100 elements in the crust, which consists almost entirely of eight elements. The remaining elements account for less than 1 % of the crust, which therefore has a very simple composition.

Because minerals are chemicals, they have special properties, which aid in their recognition. Minerals are easily identified by chemical analysis. One of the properties of minerals, which depend on their chemical composition, is specific gravity or relative weight of the minerals.

Most minerals also have a distinct crystal form. This depends on the arrangement of the atoms in each mineral. Mineral crystals fall into six systems

and these can be identified by the angles of the crystal. The way a mineral breaks in flat planes is called cleavage. This can be used in identification. Mica is an example of perfect cleavage. Minerals also break in an irregular way, which is called fracture.

All minerals have a definite hardness, which is the mineral's ability to scratch or to be scratched. Hardness is generally measured on a scale of 10. The color of minerals is not important in identification, because the color may be different due to impurities or surface changes. Streak is the color of a powered mineral, and lustre is the way the structure of a mineral reflects or breaks up light. These and many other properties help to identify them in the field and laboratory.

The way minerals form rocks is a complicated process. It involves chemical reactions at high temperatures and pressures. These different conditions, which may occur within or beneath the crust of the earth, produce a variety of rocks. While rocks are quite alike chemically, they differ greatly in their physical and mineral characteristics. All minerals are found in rocks. Diamonds are found only in a volcanic rock called kimberlite. Other minerals like quartz and calcite may be found in many different rocks.

Abridged from: Dougal Dixon. The Practical Geologist. Aurum, US, 1992.

Statement	True/False (T/F)	
1. Minerals are naturally occurring organic substances with a definite chemical composition.		
2. The Earth possesses over 5000 minerals.		
3. Minerals are easily identified by chemical analysis.		
4. Few minerals have a distinct crystal form.		
5. Mineral crystals fall into ten systems and these can be identified by the angles of the crystal.		
6. Mica is an example of perfect cleavage.		
7. Hardness is generally measured on a scale of 5.		
8. The colour of minerals is extremely important in identification.		
9. Rocks differ greatly in their physical and mineral characteristics.		
10. Diamonds are found in various types of rocks.		

VOCABULARY AND TERMINOLOGY

VI. Read the text MINERAL PROPERTIES in detail. Match the terms with their definitions.

Term	Definition
1) hardness	a) its weigth relative to the weight of an unequal volume of water

2)	habit	b) how a mineral reflects light
3)	mineral	c) how a mineral parts along weakness in its crystal lattice
4)	polymorph	d) random breakage of a mineral along no particular orientation
5)	specific gravity	e) a consistent crystal shape, which is controlled by the chemical composition of a mineral
6)	conchoidal fracture	f) its colour in the powered form
7)	lustre	g) naturally occurring inorganic substances with a definite chemical composition and specific crystal structure
8)	fracture	h) several physical forms of a mineral
9)	cleavage	i) how a mineral resists scratching
10)	streak	j) minerals break along characteristic curved surfaces that look like slightly concave, circular seashells

VII. Read the text MINERAL PROPERTIES in detail. Study the following verbs. Fill in the gaps with one of the verbs from the list in the correct form and a suitable preposition. Use the Passive Voice where necessary.

account **for**	насчитывать
aid **in**	помогать, содействовать
depend **on**	зависеть от ч.-л.
fall **into**	распадаться на ч.-л.
measure **on** a scale	измерять по шкале
break **up**	преломлять
be identified **by**	распознавать по ч.-л.

1. Minerals are easily _____ chemical analysis.
2. Mineral crystals _____ six systems, and these can _____ the angles of the crystal.
3. Lustre is the way the structure of a mineral reflects or _____light.
4. The remaining elements _____ less than 1% of the crust.
5. Hardness is generally _____ of 10.
6. Minerals have special properties that _____ their recognition.
7. One of the properties of minerals, which _____ their chemical composition is specific gravity, or relative weight of the minerals.

VIII. Choose the correct variant A, B or C.

1. Minerals are naturally occurring inorganic substances with _____.
   a) a definite chemical composition
   b) a specific crystal structure

c) both

2. There are over _____ elements in the crust, which consists almost entirely of eight elements.
   a) 1000
   b) 10
   c) 100
3. A distinct crystal form of a mineral depends on the arrangement of the _____ in each mineral.
   a) protons
   b) atoms
   c) neutrons
4. The way a mineral breaks in flat planes is called _____ .
   a) fracture
   b) breakage
   c) cleavage
5. _____ is an example of perfect cleavage.
   a) mica
   b) ore
   c) diamond

IX. Read and remember the list of the words associated with FOSSILS.

1)	fossil	– ископаемое, окаменелость
2)	remains	– останки
3)	petrifaction	– петрификация, окаменение
4)	oxydation	– окисление
5)	compound	– химическое соединение
6)	hydrogen	– водород
7)	carbon	– углерод
8)	nitrogen	– азот
9)	sulphur	– сера
10)	decomposition	– разложение
11)	under favourable conditions	– при благоприятных условиях
12)	circumstances	– обстоятельства
13)	diagenesis	–диагенез
14)	to refer to	– относиться к
15)	to dig/ dug/dug	– копать
16)	to decay	– разлагаться
17)	to resist	– сопротивляться
18)	to deposit	– осаждаться, отложиться
19)	to lithify	– окаменевать
20)	to be embedded	– залегать

FOSSILS

In common usage the word *fossil* was referred originally to anything dug out of the ground. The root Latin word is *fossilis* meaning dug up, and therefore, minerals as well as the remains of animals and plants were called fossils, but the term soon became restricted to the remains of animals and plants found in rocks. These used to be called *petrifactions*. William Smith recognized that certain fossils are known as *characteristic fossils*.

Immediately after death, organisms begin to decay. The slow process of oxidation takes place in the presence of oxygen, and simple compounds with hydrogen, carbon, nitrogen, sulphur and phosphorous are the final products. In the absence of oxygen, fermentation takes place, resulting in the formation of carbon and nitrogen. The channels through which gas has escaped from decaying organisms are sometimes preserved in sediments.

The hard parts of organisms resist decomposition more effectively than the soft parts and become buried in and protected by sediment. Under favorable conditions either the complete animal or parts of it, may be preserved in their original state.

In favorable circumstances, large numbers of dead animals can be deposited and entombed in sediments. The covering of the fossils by successive layers of sediment and the resulting increase in pressure causes the sediments to become compacted and lithified and also affects the fossils themselves.

The most important change is a reduction with increasing pressure, in the size of the pore spaces of the rocks and the consequent loss of water. This is accompanied by a series of chemical reactions, which are known as *diagenesis.* The processes of fossilization take place over long periods of time.

For all practical purposes they are restricted to the sedimentary environment and do not occur in igneous rocks which are produced by the crystallization of magma. Most fossils are the hard parts of organisms, which have been embedded in sediments and altered by chemical reaction. They may become calcified or silified and thereby resistant to attack. Carbonization plays a special role in the preservation of plant fossils. Coal was formed in this way.

Fossils are not merely interesting or beautiful structures which occur in the sediments, in which they lived or in which they were buried, but are rather the means whereby the process of evolution can be traced and the clues to the interpretation of past events are recorded cryptically in sedimentary rocks to form a diary of Earth history.

Abridged from: http://lectmania.ru/2x1b3.html

X. Read the sentences and decide if they are true (T) or false (F).

Statement	True/False (T/F)	
1. Fossils can be found in sedimentary rocks as well as igneous and metamorphic ones.		

Statement		True/False (T/F)	
2.	The process of fossilization takes place over long periods of time.		
3.	Oxygen plays an important role in the process of fossilization.		
4.	Fossils are usually preserved in different rocks.		
5.	Diagenesis is known as reduction accompanied by some chemical reactions.		
6.	Coal was formed as a result of carbonization.		
7.	The word *fossil* refers to anything in the ground.		
8.	Fossils are simply interesting and beautiful structures.		
9.	Petrifaction has the same meaning as fossils.		
10.	Fossils can be divided into several groups.		

GRAMMAR

The Passive voice

Only transitive verbs, i. e. verbs that take an object, can be changed into the passive. **Example:** *Steve wrote a letter* (transitive verb) – *A letter was written by Steve*.
By+agent is used to say who or what did the action. ***By+agent*** is omitted in the passive sentence when the agent is unknown, unimportant, obvious from the context, or when the subject of the active sentence is a word such as *someone, people, they, one, etc*. **Example:** *Someone broke the window. – The window was broken.*
In the passive, the preposition that follows a verb (**e. g. *refer to, laugh at, speak of, break into***) is placed immediately after the verb. **Example:** *Dave turned the radio off. – The radio was turned off by Dave.*

(For more details you may see Grammar Reference p. 169)

XI. Match the sentences on the left with their equivalents on the right.

1. О докладе много говорили.	A. He was answered at once.
2. Им предложили сегодня интересную лекцию.	B. These data are referred to.
3. На них полагались.	C. What films have you seen this month?
4. На него посмотрели с удивлением.	D. The report will be followed by a discussion.
5. Попов изобрел радио.	E. How many letters did you get last week?
6. Об этой статье много говорят.	

7. Сколько писем вы получили на этой неделе?
8. За ними последовали.
9. Они еще не закончили этот эксперимент.
10. Ему сразу ответили.
11. На эти данные ссылаются.
12. За докладом последует обсуждение.
13. Какие фильмы вы видели в этом месяце?
14. На это вещество было оказано воздействие
15. За статьями послали.

F. The articles were sent for.
G. This substance was acted upon.
H. They have been offered an interesting lecture today.
I. They were relied upon.
J. The report was much spoken of.
K. Radio was invented by Popov.
L. They made a lot of experiments last week.
M. They were followed.
N. He was looked at with surprise.
O. We were answered by a scientist.
P. These data ***are*** referred to.
Q. What films did you see last week?
R. They haven't finished this experiment yet.
S. How many letters have you got this week?
T. This article is much talked about.

XII. Change the sentences using the passive constructions with verbs followed by prepositions.

Example: *They spoke much of the talented actress. –*
The talented actress was much spoken of.

1. They never object to his suggestions.
2. We called in the police.
3. They will arrive at some agreement.
4. Burglars broke into the house.
5. They have always referred to this experiment.
6. They have sent for the director.
7. No one took notice of his words.
8. They took good care of these animals.
9. They listen attentively to his lectures.
10. They took down the notice.

TRANSLATION

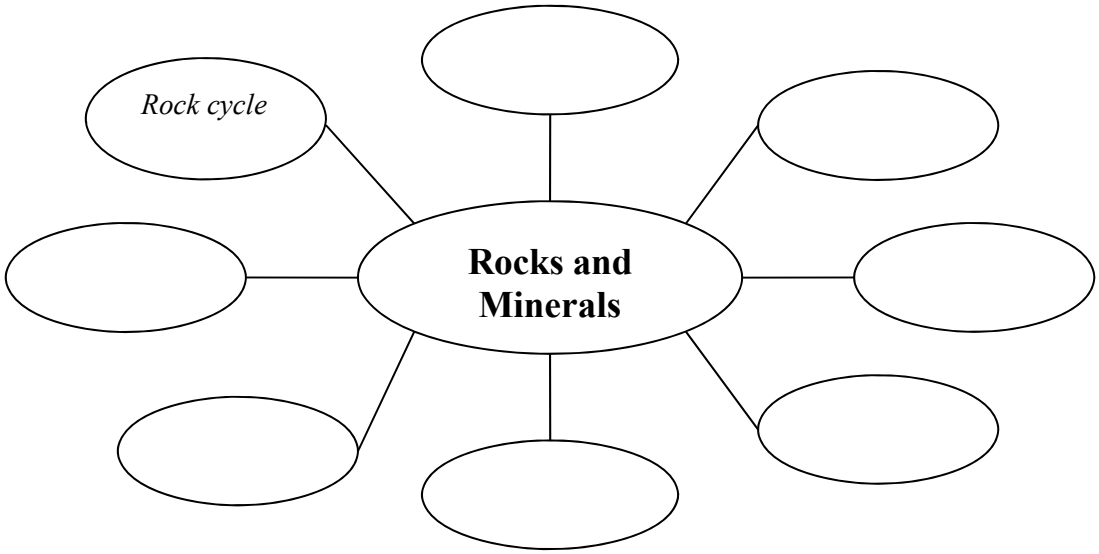
XIII. Find 10 sentences with the Passive voice in the texts of Unit 2. Write them down and translate into Russian.

SPEAKING

XIV. **Answer the questions concerned with MINERAL PROPERTIES.**

1. What are minerals?
2. How many minerals are there in the Eatrh?
3. What are two parameters of minerals?
4. What forms do the most minerals have?
5. What is “cleavage”?
6. How is the ability of a mineral to scratch or to be scratched called?
7. Why the colour of a mineral is *not* important in identification?

XV. Fill in the spidergram with the words associated with Rocks and Minerals and explain your associations.



Example: *The rock cycle demonstrates the relationships among the types of rocks.*

XVI. Describe the picture in 10 sentences.

a 

b 

Example: *Students are studying the collection of minerals.*

WRITING

XVII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176)

WEATHERING OF ROCKS

All rocks, which are exposed on the Earth's surface (high mountain peaks, deserts) are decomposed to a certain degree. The process of rock disintegration by the direct influence of local atmospheric conditions on the Earth's surface is called weathering.

The main cause of physical weathering is the change in temperature that takes place with the succession of day and night. This phenomenon can best be observed in the deserts and high mountains where the changes in temperature are common.

During the day under the influence of heat, rocks expand, whereas at night they begin to contract. As rocks are generally composed of different minerals, their expansion and contraction do not occur uniformly. As a result of this rocks crack. At the beginning these cracks or fissures are hardly noticeable, but gradually they become wider and deeper until the whole surface of rock is finally transformed into gravel, sand or dust.

The decomposition of rocks under the direct influence of heat and cold is called physical weathering.

Rocks are subjected not only to physical decomposition, but also to chemical weathering, i. e. to the action of chemical agents, such as water, carbon dioxide and oxygen. In a general way, chemical weathering is an acid attack on the rocks of the Earth's crust. Only few minerals and rocks are resistant to the action of natural waters. The solvent action of water is stronger, when it contains carbon dioxide. Water causes more complex and varied changes. With the participation of oxygen and carbon dioxide up to 90 per cent of rocks is transformed into soluble minerals, which are carried away by the waters.

Organisms and plants also take part in the disintegration of rocks. Certain marine organisms accelerate the destruction of rocks by making holes in them to live in. The action of plants can often be even more destructive. Their roots penetrate into the fissures of rocks and develop the lateral pressure, which fractures and destroys rocks.

Abridged from: https://studopedia.su/14_100983_Weathering-of-Rocks.html

SELF-STUDY

PROPERTIES OF MINERALS

LEAD-IN

Minerals possess a number of **physical** and **chemical properties.**

I. Read and remember the list of the words associated with mineral properties.

1) to distinguish – различать
2) distinctive – отличительный
3) luster – блеск
4) transparency – прозрачность
5) translucent – просвечивающий
6) to reflect – отражать
7) crystal system – кристаллическая система, сингония
8) crystal habits – кристаллическая структура, форма кристаллизации
9) dodecahedral – 12-гранный
10) octahedral – 8-гранный
11) columnar – колоннообразный, столбчатый
12) pinacoidal – пинакоидальный
13) cleavage – спайность, отслоение
14) fracture – трещина разлома, разрывное нарушение
15) hardness – твердость
16) specific gravity – относительная плотность
17) mica – слюда
18) feldspar – полевой шпат
19) streak – цвет черты
20) orthogonal – взаимно перпендикулятный, прямоугольный

II. Pay attention to the pronunciation of the following terms.

[s] transparen**c**y, translu**c**ent, spe**c**ific,
[k] **c**olumnar, distin**c**tive, specifi**c,** fra**c**ture
[i] transparenc**y**, d**i**st**i**ngu**i**sh, cr**y**stal

III. Pay attention to the stress in the following words.

ref´lect	dis´tinguish	´cleavage
or´thogonal	dodeca´hedral	trans´lucent
´mica	res´ponsible	´columnar

READING

IV. Read the text and write whether the following statements are true (T) or false (F).

Statement	True/False (T/F)	
1. Minerals are distinguished only by their chemical properties.		
2. Colour is a physical characteristic of mineral properties.		
3. Metallic luster is often found in oxide minerals.		
4. Crystal system is one of the most important diagnostic means.		
5. Crystal can display a lot of various forms.		
6. Quartz has both cleavage and fracture.		
7. Sulphides and oxides have much higher specific gravity than silicates.		
8. Streak is not so useful in diagnistics as colour.		

MAIN PHYSICAL PROPERTIES OF MINERALS

Minerals are distinguished by their *physical* and *chemical* properties. The same properties are responsible for the many of the mechanical characteristics of rocks. Most common minerals can be recognized from one or two characteristics.

Physical characteristics:

Colour – the colour of minerals is rarely diagnostic when used alone but some minerals are very distinctively coloured. (Native sulphur – yellow; amethyst quartz – purple; azurite – blue)

Luster – is the way in which light is reflected from mineral surfaces and is more frequently diagnostic than color. Metallic luster is often found in sulphide minerals; non-metallic luster includes glassy, dull and earthy.

Transparency – the ability to see through a mineral is a measure of transparency. Reflecting surfaces are called translucent.

Crystal system – is a very important diagnostic aid. Minerals fall into one of six crystal classes.

Crystal habits – this is the name given to the form or shape of crystals. Cubic, dodecahedral, octahedral, rhombohedral, prismatic, columnar, pinacoidal, and pyramidal are a few of the many forms that crystal can display.

Cleavage – this refers to the characteristic manner in which minerals split along planes determined by their crystal structure. Mica has a perfect basal cleavage in one direction and splits into thin sheets. Feldspars commonly show two strong cleavages. Cubic minerals such as halite often display three mutually orthogonal cleavage directions.

Fracture is mineral breakage, which is unrelated to crystal structure. Quartz has no cleavage but can show conchoidal fracture patterns.

Hardness is measured on a non-linear relative scale called Mohs' Scale of Hardness.

Specific gravity is an easily measured physical property that can be readily estimated. In general, sulphides and oxides have much higher specific gravities than silicates.

Streak is the name given to the color of a mineral when powdered by abrasion against a stronger material. Streak is a much more useful diagnostic characteristic than color.

Abridged from: Press Siever. Understanding Earth. Freeema & Co, 1994.

V. Read the text about maximizing oil yield and match the headings 1-4 with paragraphs A-D.

1. Hardness of kyanite ____
2. Effects of weathering ____
3. Variable hardness of minerals ____
4. How craftsmen work with diamonds ____

HARDNESS VARIATIONS IN A SINGLE MINERAL

A. Although reference books and websites often list a single hardness for each mineral, many minerals have variable hardness. They have greater or lesser hardness depending upon the direction in which they are being scratched.

B. A well-known example of a mineral with variable hardness is *kyanite*. Kyanite frequently occurs in blade-shaped crystals. These crystals have a hardness of about 5, if they are tested parallel to the long axis of the crystal, and a hardness of about 7, if they are tested parallel to the short axis of a crystal. Why? These different directions encounter different bonding environments in the kyanite crystal. The bonds that resist scratching parallel to the long axis of the bladed crystal are weaker than those encountered when scratching across the width of the crystal. Intermediate hardnesses are encountered in other directions.

C. Another example is diamond. The people who cut diamonds have known about its variable hardness for hundreds of years. They know that parallel to the octahedral crystal faces, a diamond crystal is almost impossible to saw and very difficult to polish. The diamond can be broken in this direction by cleaving, and the best method for cutting it in this direction is with a laser. The softest and best direction to saw or polish a diamond crystal is parallel to its cubic crystal faces. This information is critical knowledge for the crafts-

men who plan the design of a faceted diamond. Understanding it and working with it saves time, saves money and creates a better product with less waste.

D. Weathering can also influence the hardness of a mineral specimen. Weathering changes a mineral's composition, with the weathering a product is usually softer than the original material. When testing the hardness or streak or other property of a mineral, the best way to test is on a freshly broken surface with expected luster that has not been exposed to weathering.
Abridged from: https://geology.com/minerals/mohs-hardness-scale.shtml

VOCABULARY AND TERMINOLOGY

VI. Read the text HARDNESS VARIATIONS IN A SINGLE MINERAL in detail and match the words in collum A with the words in column B to form word-groups. Then give Russian equivalents to these word-groups.

Example: *(1b) a single hardness for each mineral – единственный коэффициент твердости для каждого минерала*

	A		**B**
1)	~~a single hardness~~	a)	the direction
2)	greater or lesser	b)	~~for each mineral~~
3)	weathering changes	c)	to the long axis
4)	to polish	d)	with less wastes
5)	to depend upon	e)	hardness
6)	the design	f)	the property of a mineral
7)	to be tested parallel	g)	a diamond crystal
8)	impossible	h)	of a faceted diamond
9)	a better product	i)	mineral's composition
10)	to test	j)	to saw

VII. For questions 1–5, choose one of the words (a–f) that best completes a gap in the text. You can use each word only once. There is one extra word.

a)	**carbon**	**c)**	**hydrogen**	**e)**	**sedimentary**
b)	**lignite**	**d)**	**impurities**	**f)**	**layers**

COAL VARIETIES

Coal is a solid, combustible_____, 1)_____, organic rocks. Coal formed when lush vegetation from warm swampy areas died and was buried to later be consolidated between other rock 2)_____ and was altered by the combined effects of pressure and heat over millions of years. 3)_____ is the main component of coal and it also contains varying amounts of hydrogen, oxygen, nitrogen, sulphur and other 4)_____. Many different classifications of coal are used around the world. However, the three main types of coal are_____ _____ anthracite, bituminous and 5)_____.

VIII. Fill in the gaps with the derivatives.

hard harden hardness harder hardy

1. We need to take into account such local geological conditions as _____ and water content of the rock surrouding the area.
2. They were working very _____ while conducting field investigations.
3. This dog is robust, _____ and versatile. It is a good shepard, hunter and guardian.
4. Oil extraction has become ten times _____ here than a year ago.
5. These cells have an ability to rearrange and _____, giving them the appearance of sand.

IX. Complete the sentences using the information from the text HARDNESS VARIATIONS IN A SINGLE MINERAL.

1. Reference books and websites very often mention _____ for each mineral.
2. Kyanite frequently occurs in _____ crystals.
3. Different directions encounter different _____ in the kyanite crystal.
4. The softest and best _____ to saw or polish a diamond crystal is _____ to its cubic crystal faces.
5. With the weathering a product is usually _____ than the _____ material.
6. At testing the streak of a mineral the best way to test is on a freshly broken surface with expected _____.

X. Answer the questions.

1. What types of properties do minerals possess?
2. What physical properties of minerals can you enumerate?
3. What are the most important physical properties of minerals?
4. What are the less important physical properties of minerals?
5. Why is transparency?
6. What is cleavage?
7. Is fracture related to a crystal structure?
8. Is it possible for a mineral to have different hardness at the same time?
9. How was coal formed?
10. How many types of coal do you know?

GRAMMAR

XI. Choose the correct variant a, b or c.

1. What's the matter? My car _____ .
   a) was just stolen
   b) has just been stolen
   c) is just stolen
2. One of the theatres in our city _____ now.
   a) is being reconstructed
   b) was being reconstructed
   c) will be reconstructed
3. That house _____ a long time ago.
   a) has been sold
   b) was sold
   c) is sold
4. Jin said the room _____.
   a) will have already been cleaned
   b) will be cleaned
   c) had already been cleaned
5. All the banks _____ on sundays
   a) are closed
   b) had been closed
   c) are been closed
6. The documents _____ by 5 p.m.
   a) will be signed
   b) are signed
   c) will have been signed
7. We _____ on our way home yesterday.
   a) were being followed
   b) are being followed
   c) have been followed
8. My sister _____ to hospital tomorrow.
   a) is being taken
   b) will be taken
   c) was taken
9. The conference room _____ at the moment.
   a) was being used
   b) had been used
   c) is being used
10. When we arrived at the airport, we found that the flight _____ .
    a) had been cancelled
    b) is being cancelled
    c) has been cancelled

11. The flowers in the flowerbeds _____ by this evening.
    a) are being watered
    b) were watered
    c) wil have been watered
12. America _____ several centuries ago.
    a) had been discovered
    b) was discovered
    c) will be discovered
13. An old woman _____ while she was living with her children.
    a) is being looked after
    b) was being looked after
    c) will be looked after
14. The exams _____ by 3 in the afternoon.
    a) will have been finished
    b) were being finished
    c) are being finished
15. When we returned home, the walls _____ .
    a) has been painted
    b) had been painted
    c) will be painted

TRANSLATION

XII. Translate the following sentences into Russian. Pay attention to the Passive voice.

1. Modern geology is closely connected with other sciences.
2. Mineral and rocks are subjected to a process of constant development depending on geological conditions.
3. The scientists working in the field of geology penetrate deeply into the mysteries of the Earth.
4. Researchers are continuing to study the conditions and places of gas collection within the Earth's crust.
5. Ground water is often thought of as an underground river or lake.
6. V.A. Obruchev and A.P. Karpinsky could be mentioned among the founders of the Russian school of geology.
7. The oceanic crust by contrast with the continental crust is not studied completely.
8. The word fossil was originally referred to anything dug from the ground.
9. Sedimentary rocks have been formed of sediments, accumulation of solid material.

10. Scientists of the Russian Academy of Sciences have been active in developing geostatistics and computer techniques for geology.

WRITING

XIII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176)

MINERAL SHAPES AND CLEAVAGE

A mineral develops a characteristic three-dimensional shape called a crystal. The crystal form reflects the arrangement of atoms in the molecule. The crystal shape is an important clue to the identification of a particular mineral and geologists recognize six different crystal systems. Each is based on the number of axes of symmetry developed. The sides of a crystal are termed faces. There are six crystal systems that include all minerals. Some mineral compounds can form more than one mineral with entirely different crystal structures.

Related to the crystal structure is a property called cleavage. Planes of weakness in the crystal lattice reveal themselves in the tendency for the crystal to split in a certain direction. Cleavage is often very diagnostic as a mineral identification method since weaknesses in the crystal lattice will always be of the same nature in the same mineral. Quartz is tightly bonded in its crystalline structure and produces no cleavage. Mica has one direction of cleavage while calcite has three directions.

Unfortunately for the geologists, minerals hardly ever form crystals. When a rock forms, all the chemical components organize themselves into minerals. Only if a mineral can develop in a fluid, then a good crystal form develops.

Abridged from: Dougal Dixon. The Practical Geologist. The introductory guide to the basics of geology and to collecting and identifying rocks. 1992.

KEY TO SELF-STUDY

IV. 1F 2T 3F 4T 5T 6F 7T 8F

V. 1B 2D 3A 4C

VI. Suggested answer

2e greater or lesser hardness – большая или меньшая твердость
3i weathering changes a mineral's composition – выветривание меняет состав минерала
4g to polish a diamond crystal – полировать алмаз
5a to depend upon the direction – зависеть от направления
6h the design of a faceted diamond – дизайн ограненного бриллианта
7c to be tested parallel to the long axis – тестировать относительно длинной оси
8j impossible to saw – невозможно распилить
9d a better product with less wastes – лучший продукт с меньшими затратами
10f to test the properties of a mineral – проверять свойства минерала

VII. 1e 2f 3a 4d 5b

VIII. 1 hardness 2 hard 3 hardy 4 harder 5 harden

IX. 1 a single hardness 2 blade-shaped 3 bonding environments 4 direction/parallel 5 softer/material 6 luster

XI. 1b 2a 3b 4c 5a 6c 7a 8b 9c 10a 11c 12b 13b 14a 15b

XII. Suggested answer

1. Современная геология тесно связана с другими науками.
2. Минеральные и горные породы подвергаются процессу непрерывного изменения в зависимости от геологических условий.
3. Ученые, работающие в области геологии, постигли тайны Земли.
4. Исследователи продолжают изучать условия и места скопления газа в земной коре.
5. Грунтовые воды считаются подземной рекой или озером.
6. В.А. Обручева и А.П. Карпинского следует упомянуть среди основателей русской школы геологии.
7. Океаническая кора в отличие от континентальной не изучена полностью.
8. Слово «ископаемое» первоначально относилось к тому, что было извлечено из земли.
9. Осадочные породы сформированы из отложений, накопления твердого вещества.
10. Ученые Российской академии наук активно участвуют в разработке геостатистики и компьютерных технологий для геологии.

TEST 1

Variant 1

READING

I. Read the text and match the headings (1–4) with the paragraphs (A–E).

1. Regional geology maps ____
2. Peculiarities of reconnaissance maps ____
3. Special purpose maps ____
4. Types of geological maps ____
5. Large-scale detailed maps ____

GEOLOGICAL MAPS

A. Geological maps can be divided into four main categories. These include reconnaissance maps, regional geology maps, large-scale detailed maps of limited areas and special purpose maps. Small-scale maps covering very large regions are usually complied from information selected from one or more of these categories.

B. A reconnaissance map is designed to give as much information as possible about the geology of an unknown area as quickly as possible, using a scale of 1:250 000 or less. Some reconnaissance maps are made by interpreting the geology from aerial photographs with only a minimum amount of fieldwork.

C. A regional geology map is designed to give more information than a reconnaissance map, using a scale of 1: 25 000 or 1: 50 000. Regional geology maps should be plotted on a reliable topographic basis. Unfortunately, in some countries, regional geology maps are often based on inadequate topographic information and, therefore, the geologist must survey the topography himself. Regional geology mapping incorporates techniques which can help and which the budget will allow, including geophysical and drilling techniques.

D. Detailed maps on a large-scale are usually made to investigate special geological problems resulting from discoveries made during regional mapping or perhaps with an economic objective such as an ore extraction or dam construction.

E. Special purpose maps on a scale of 1:1 000–1: 2 500 are many and varied.They include detailed large-scale maps of small areas to record specific geological features, such as open pit mines. Other special purpose maps include geophysical and geochemical maps, sub-surface maps, etc. Many special purpose maps are prepared as transparent overlays to be superimposed on a normal geological map of the same scale.

Abridged from: Paul Nixon & Alfredo Bezzi. English for Geologists,1998.

II. Read about rock eating bacteria. Write whether the following statements are true (T) or false (F).

Statement	True/False(T/F)	
1. Scientists have found few bacreria at the bottom of the ocean.		
2. Three to four times more bacteria live on the rocks of the seafloor than in the water above.		
3. These bacteria are all of the same species.		
4. To survive and grow living creatures don't need any energy.		
5. Ocean crust supports more bacteria than seawater above it.		
6. These bacteria aren't able to get nutrition from the basalt rocks.		

ROCK EATING BACTERIA FOUND AT THE BOTTOM OF THE OCEAN

Has anyone ever told you that you shouldn't eat things that you find on the floor? Well, the rules are different for bacteria. Scientists have found tons of bacteria at the bottom of the ocean that appear to be "feeding" off the seafloor.

The deep seafloor used to be thought of as an extreme environment where life could not survive. But this is not the case. Scientists have found that areas of the seafloor that look deserted are actually teeming with living things – very tiny living things – bacteria.

Scientists have known for some time that there are bacteria down there, but they didn't know how much. Now they found three to four times more bacteria living on rocks of the seafloor than in the waters above. They also found that the bacteria were very diverse – with many different species.

For living things to survive and grow they need a way to get energy. The researchers wondered where in this dark cold environment the bacteria were finding the energy they needed. From the research, they knew that the ocean crust supports more bacteria than seawater above it. The scientists hypothesized that the bacteria might be getting the energy they need from the rocks.

In the lab, they calculated how many bacteria could survive from the energy provided by reactions with the basalt rocks of the ocean floor. Then, they compared this calculation to the actual number of bacteria that they found down there. The numbers were similar, suggesting that the bacteria are able to get their nutrition from the rocks.

Abridged from: https://www.windows2universe.org/?page=/headline_universe/olpa/oceanmicrobes_28may08.html

III. Read the text IGNEOUS RELATIONSHIPS and answer the questions.

1. What type of pattern will igneous rocks show?
2. Where is magma derived from?
3. How granite is produced?
4. What is the composition of magma?
5. What is chemical analysis used for?
6. What processes can produce different igneous rocks?

IGNEOUS RELATIONSHIPS

The igneous rocks of a particular episode of activity will generally fall into a pattern of extrusion and/or intrusion. A parental magma of a particular chemical composition provides the source material for both types. This magma may be basic, derived from beneath the crust, acidic, from the melting of continental crust during orogenesis, or intermediate from island arc volcanoes. The composition of the igneous rocks varies from the parental norm because of either assimilation or melting of additional material, or differentiation. In the latter case the ferromagnesian minerals and the calcic plagioclase settle out, leaving a residual liquid richer in sodic plagioclase, orthoclase, and quartz. Given a basic parental magma, the crystal fractionation with removal of the residual liquid will produce an ultrabasic rock and a small proportion of granite. The reconstruction of magma differentiation is a matter for the laboratory as much as the field. The order of events, the relative chronology, is a matter of field observation, while accurate chemical analyses of both major and trace elements and details of mineral crystallization are a matter for the laboratory.

The contact between an intrusion and a sedimentary rock will usually leave no doubt that the igneous rock was injected as magma; the main evidence of this is the chilling of the intrusion against the contact and the inclusion of xenoliths of country rock. The same features are present but less obvious when one igneous rock intrudes another hot igneous rock or high-grade metamorphic rock because there may be little chilling of the later.

Abridged from: Paul Nixon & Alfredo Bezzi. English for Geologists, 1998.

VOCABULARY AND TERMINOLOGY

IV. Read the text GEOLOGICAL MAPS in detail and choose the correct variant A, B, C or D.

1. What topic is the text mainly concerned with?
   a) geological interpretations
   b) geological maps
   c) information about unknown areas
   d) topographic information

2. It can be inferred from the text that geological maps.
   a) are important in our lives
   b) have some significance in identifying different areas
   c) have a great consumer appeal
   d) are very difficult to design
3. According to the passage geological maps can be divided into.
   a) sections
   b) groups
   c) categories
   d) parts
4. According to the text, which of the geological maps gives more information.
   a) reconnaissance map
   b) detailed map
   c) regional map
   d) special map
5. The paragraph following this text would probably discuss.
   a) how to design geological maps
   b) the importance of geological maps
   c) where geological maps are used
   d) advantages and disadvantages of geological maps

V. Match the words and word-groups (1–10) with their translations (a–j).

1)	reconnaissance maps	a)	карьер, разрез, рудник с открытыми работами
2)	to plot	b)	полевая съемка, полевые работы
3)	open pit mine	c)	региональные геологические карты
4)	special purpose maps	d)	добыча руды
5)	fieldwork	e)	топографическое содержание
6)	drilling techniques	f)	наносить на карту, составлять чертеж
7)	regional geology maps	g)	крупномасштабные карты
8)	ore extraction	h)	технология бурения
9)	topographic basis	i)	рекогносцировочная карта, рабочая схематическая карта
10)	large-scale detailed maps	j)	карты специального назначения

VI. For questions 1–5, choose one of the words (a-f) that best completes a gap in the text. You can use each word only once. There is one extra word.

a)	**periodic**	**c)**	**element**	**e)**	**deposits**
b)	**includes**	**d)**	**chemical**	**f)**	**definition**

WHAT ARE REEs?

REEs or Rare earth elements are a group of seventeen 1) ____ elements that occur together in the 2) ____ table. The group consists of yttrium and the 15 lanthanide elements (lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium). Scandium is found in most rare earth element 3) ____ and is sometimes classified as a rare earth element. The International Union of Pure and Applied Chemistry 4) ____ scandium in their rare earth element 5) ____.

VII. Fill in the gaps with the given derivatives.

extract extraction extracting extracted extractive

1. This is hydraulic fracturing to _____ oil and gas.
2. The invention relates to a facility for _____ of brass, zink oxide and copper oxide from brass foundry slag.
3. Industrial development is slow, though there have been some results in the _____ sectors.
4. Mineral _____ and processing require large inputs of energy.
5. All these _____ resources become wastes relatively quickly.

VIII. Complete the summary of the text GEOLOGICAL MAPS. Use only one word in each sentence.

1. Geological maps can be divided into _____ main categories.
2. A reconnaissance map is desidned to give as much _____ as possible about the geology of an unknown area.
3. A regional geology map is designed to give more information than a _____ map.
4. Regional geology maps should be plotted on a reliable _____ basis.
5. Large-scale detailed maps are usually made to _____ special geological problems.
6. Large-scale detailed maps often have an _____ objective.
7. Special purpose maps include large-scale detailed maps of small areas to record specific geological _____ .

GRAMMAR

IX. Translate the given sentences into Russian. Then put these sentences into the Active or Passive voice.

Example: *He is reading a book now. – Он читает книгу суйчас. – A book is being read by him now.*

1. An engineer developed a new device.
2. A new device will be developed.
3. He has developed a new device.
4. A new device is being developed now.
5. The device will have been developed by the next month.

X. Translate the sentences into English paying attention to the passive forms. Identify the tense.

Example: *На английском языке разговаривают по всему миру. – English is spoken all over the world. (Present Simple Passive)*

1. Дома строятся каждый год.
2. В прошлом году на нашей улице был построен новый дом.
3. Новый дом на нашей улице был построен в этом году.
4. Новый дом на нашей улице будет построен к ноябрю.
5. В следующем году на нашей улице будет построен новый дом.
6. Новый дом будет построен к сентябрю в следующем году.
7. Новый дом на нашей улице строили с сентября до июля.
8. Когда я приехал, на нашей улице строили новый дом.
9. Сейчас на нашей улице строится новый дом.

TRANSLATION

XI. Find 10 sentences with the Passive Voice in the texts of Variant 1. Write them down and translate into Russian.

WRITING

XII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176)

STRATIFICATION

Most sedimentary rocks are arranged in more or less distinct layers: that is they are stratified. Stratification consists primarily in the superposition of layers one on another. Layers of like constitution or compactness may be separated by films of different material. The bedded arrangement is due to various causes, but primarily to the varying agitation of waters in which the sediments were laid down.

Where depositing waters are agitated vigorously to the bottom, coarse sediment is deposited. Where waters are quiet at the bottom, the sediment is

fine. The terms layer and bed generally are used as synonyms, while laminae are thinner divisions of the same sort. The term stratum is sometimes applied to one layer, and to all the consecutive layers of the same sort of rock. For the latter meaning the term formation is often used. The commoner sorts of bedded rock are limestones, shales, and conglomerates. In many places the bedding of limestones is caused by films of clayey matter between the layers, the films causing natural partings. Shales are normally laminated as well as bedded, and the lamination may be- more notable than the thicker bedding. Some sandstones are divided into beds by shally or clayey partings. Sandstones may be thick or thin bedded.

Abridged from: Paul Nixon & Alfredo Bezzi. English for Geologists,1998.

TEST 1

Variant 2

READING

I. Read the text and match the headings (1–4) with the paragraphs (A–D).

1. What means “acidic” in geology? ____
2. Types of igneous rocks ____
3. Classification based on a grain size ____
4. Types of rocks ____

SOME CRITERIA FOR CLASSIFYING INTRUSIVE IGNEOUS ROCKS

A. Rocks are subdivided on the basis of their origin. The three major categories are igneous, metamorphic, and sedimentary. Although there are some differences in mineral composition among the three rock types, it is more useful to discuss mineralogical and textural attributes for each group separately.

B. The subdivision of igneous rocks is made on the basis of their mineral assemblage and bulk chemistry. One of the criteria is the amount of silica contained in the rock. Rocks with a high silica content (>66 %) are called acidic and those with a low silica content (44–52 %) are called basic.

C. Differently from chemistry, in geology, "acidic" does not mean high in acid content but high in silica. Granite, rich in silica, is the less abundant acidic rock. Gabbro, poor in silica, is the more abundant basic rock.

D. Another basis for classification of igneous rocks is textural. In this classification, rocks are divided on the basis of their grain size into phanerites (coarse-grained) and aphanites (fine-grained). The more rapidly the magma cools, the finer the grain size and the poorer the crystallinity. The less rapidly the magma cools the coarser the grain.

Abridged from: Paul Nixon & Alfredo Bezzi. English for Geologists, 1998.

II. Read about minerals. Write whether the following statements are true (T) or false (F).

Statement	True/False (T/F)	
1. The main properties of minerals are cleavage, crystal form, hardness, color.		
2. Limestone, diamonds, cement and salt are metallic minerals		
3. Economic minerals are those minerals that are economically important		

Statement	True/False (T/F)	
4. Oxygen, silicon, titanium, iron are the components of most minerals		
5. Iron is the most important industrial metal because of its most important property to become magnetized		
6. Iron deposits associated with sedimentary rocks are usually small, but rich with magnetite		

MINERALS

Minerals that make up rocks are defined as inorganic substances which occur naturally and have a definite chemical composition and physical properties. The major properties are color, crystal form, hardness, cleavage and others. Cleavage is one of the most diagnostically useful mineralogical properties which can be found throughout the mineral.

Minerals can be grouped into two broad categories: 1) metals (aluminium, copper, gold, silver iron, etc.) and 2) non-metallic minerals (diamonds, salt, limestone, cement, sulphur and asbestos). When minerals occur so that they can be worked at a profit, they are called ore deposits. Economic minerals are those which are of economic importance and include both metallic and non- metallic minerals.

Most minerals consist of several elements: oxygen, silicon, titanium, aluminuim, iron, magnesium, etc. They make up more than 99% by weight of all rock-forming minerals. For example, iron is one of the most abundant metals in the Earth's crust. There are three important classes of iron deposits: deposits associated with igneous rocks; residual deposits and sedimentary deposits. Iron deposits associated with igneous rocks are usually small but very rich in haematite and magnetite. Residual deposits of iron minerals are formed when weathering occurs.

Iron deposits formed this way are very widespread. Sedimentary iron deposits make up most of the world's current production. Iron is obviously the most important of all industrial metals. It has played a large part in the development of our modern civilization. From a scientific point of view, iron's most important property is that it becomes magnetized.

Abridged from: https://geology.com/minerals/what-is-a-mineral.shtml

III. Read the text VOLCANOES and answer the questions.

1. What is magma?
2. Where is magma located?
3. What is lava? Where can one find lava?
4. What is the amount of silica in magma?
5. What makes an eruption more explosive?

6. What is the average temperature of basalt lavas?
7. Why do rhyolite eruptions tend to be large, explosive and catastrophic?

VOLCANOES

Magma is the term for any molten silicate material, whether below the surface or on the surface. **Lava** is magma that is flowing across the surface, an **extrusive** magma.

Although the crust and mantle are solid there may occasionally be small amounts of magma generated, usually near the surface. At mid-ocean ridges (divergent plate boundaries) primary magma is generated in the upper mantle. These primary magmas are **basaltic** in composition and have a characteristic chemistry and are called mid-ocean-ridge basalts.

Magmas may contain 45 to 75 % silica (SiO_2). The more silica, the more viscous the lava and the more explosive the eruption.

Primary oceanic lavas are low in silica and are said to be **mafic** in composition. **Basalt** is a mafic volcanic rock typical for ocean basins. It is dark in color and dense (density = 3,1–3,2 g/cm^3).

Basaltic eruptions are commonly non-explosive and magma may build up a **cinder cone** when magma first reaches the surface. The cone may later be breached and a **lava flow** may emerge from the **vent**. The first part of the flow is relatively cool and viscous. This part of the flow forms a rubbly surface called an **aa** flow. As eruption continues and more and more magma flow out the temperature of the magma delivered to the flow front may increase which decreases the viscosity. The high temperature lava forms a ropey surface called a **pahoehoe** flow. Temperatures of basaltic lavas are typically 1100 to 1200 °C.

Continental magmas are richer in **SiO_2** and are said to be **felsic** or **silicic** in composition. **Rhyolite** is a felsic volcanic rock typical for continental regions. It is usually light in color and has a relatively low density (density = = 2,5–2,7 g/cm^3). It is compositionally equivalent to granite (an **intrusive** rock).

Rhyolite eruptions tend to be large, explosive and catastrophic. The magma is commonly ponded in a near-surface **magma chamber**, which may be up to tens of kilometers in diameter. The magma may contain 1 to 2 % water by weight, which causes the magma to foam when pressure is released.
Abridged from: General Geology. Textbook. Part I. Tomsk: TPU, 2004.

VOCABULARY AND TERMINOLOGY

IV. Read the text VOLCANOES in detail and match the words and word-groups (1–10) with their definitions (a–j).

1)	lava	a)	a felsic volcanic rock typical for continental regions
2)	magma	b)	flow front tht increases and decreases the viscosity; the high temperature forms a ropy surface

3)	pahoehoe	c)	consisting mostly of feldspars, quarts and other light-coloured minerals
4)	basalt	d)	a reservoir of magma near the surface
5)	rhyolite	e)	an opening exposed on the Earth's surface where volcanic material is emitted
6)	aa	f)	molten rock generated by geothermal energy and expelled through fractures in planetary crust or in an eruption
7)	magma chamber	g)	a mafic volcanir rock typical for ocean basins
8)	felsic	h)	the flow is relatively cool and viscous and forms a rubbly surface
9)	vent	i)	relating to a group of dark-coloured minerals
10)	mafic	j)	a mixture of molten or semi-molten rock, volatiles and solids that is found beneath the surface of the Earth

V. Read the text VOLCANOES in detail and choose the correct variant a, b, c or d.

1. What topic is the text mainly concerned with?
   a) volcanoes
   b) types of magamas and lavas
   c) geological time
   d) rock cycle
2. As the magma rises, the pressure is_____.
   a) stabilized
   b) increased
   c) reduced
   d) the same
3. What is a magma chamber?
   a) a reservoir of molten rock
   b) a reservoir of gas under pressure
   c) a reservoir of gas-rich molten rock
   d) a reservoir of boiling water
4. What forces magma to the Earth's surface?
   a) pressure
   b) gravity
   c) temperature
   d) resistance
5. What does *vent* mean?
   a) circle
   b) hole
   c) outlet
   d) exodus

VI. For questions 1–5, choose one of the words (a–f) that best completes a gap in the text. You can use each word only once. There is one extra word.

a)	**diverge**	**c)**	**dikes**	**e)**	**occur**
b)	**inclined**	**d)**	**manifestation**	**f)**	**below**

IGNEOUS RELATIONSHIPS

The contact between an intrusion and a sedimentary rock will usually leave no doubt that the igneous rock was injected as magma; the main 1) ____ of this is the chilling of the intrusion against the contact and the inclusion of xenoliths of country rock. The same features are present, but less obvious, when one igneous rock intrudes another hot igneous rock or high-grade metamorphic rock, because there may be little chilling of the later.

In volcanic regions, which have intrusive rocks 2) ___, intrusions often 3) _____ intruded into the lavas and pyroclastic rocks. The 4) ____and pipes make up vertically through the extrusive rocks and any interbedded sediments, while horizontal or 5) ____ sills may be interleaved with them.

VII. Fill in the gaps with the given derivatives.

intrude intrusion intruding intruder intrusive

1. _____ rock is formed, when magma crystallizes and solidifies underground to form intrusions.
2. You cannot _____ on these people's lives and say to them what to do.
3. Salt water is _____ into surface and affects groundwater system.
4. Two years ago an _____ broke into the house and attacked a married couple.
5. _____ is a forcible entry of molten rock or magma into or between other rock formations.

VIII. Complete the summary of the text MINERALS. Use only one word in each sentence.

1. Minerals that make up rocks are defined as _____ substances.
2. Minerals possess a definite chemical composition and physical _____ .
3. The major properties are colour, crystal form, _____, cleavage and others.
4. _____ is one of the most diagnostically useful mineralogical properties.
5. Minerals can be grouped into two broad categories:_____ and non-metallic minerals.
6. Iron is one of the most _____ metals in the Earth's crust.
7. Iron has played an important role in the development of our modern _____.

GRAMMAR

IX. Rewrite the following sentences in the Passive voice.

1. I took him for a walk.
2. She will forget your telephone number.
3. We'll book tickets tomorrow.
4. We met her at the station.
5. We discuss such problems at the meeting.
6. They will build a new cinema in this street.
7. I often invite my friend to the theatre.
8. I'll translate the article tomorrow.
9. He made some mistakes in the report.

X. Make sentences by putting the words in the correct order. Translate these sentences into Russian.

Example: *named/ A 24-year-old woman/ been/ Young Writer of the Year/ has/ from London. –*

A 24-year-old woman from London has been named Young Writer of the Year.

1. Is/ English/ the international language of business/ generally considered.
2. Being/English/taught/in some countries/ are/ from thq age of two/ children.
3. Founded/ was/ the company/ in 1992.
4. A job/ has/ in New York/ my husband/ offered/ been.
5. Was/ my grandmother/ taught/ I/ the piano/ by/ to play.
6. Decorated/ for the wedding/was/with beautiful yellow and white flowers/the room.
7. Being/ my office/ last week/ repaired/ was.
8. You ever/ have/ been/ by a snake/ bitten?
9. Of the accident/ not/ at the moment/ known/ the cause/ is.

TRANSLATION

XI. Find 10 sentences with the Passive Voice in the texts of Variant 2, write them down and translate into Russian.

WRITING

XII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176).

GEOLOGICAL TIME SCALE

Geologists have created a geologic time scale to provide a common vocabulary for talking about past events. The practice of determining when past geologic events occurred is called geochronology. This practice began in the 1700's and has sometimes involved some personal and international disputes

that led to differences in terminology. Today the geologic time scale is generally agreed upon and used by scientists around the world, dividing time into eons, eras, periods and epochs.

The identification of strata by the fossils they contained, pioneered by William Smith, Georges Cuvier, and Alexandre Brogniart in the early 19th century, enabled geologists to divide Earth history more finely and precisely. It also enabled them to correlate strata across national (or even continental) boundaries. If two strata (however distant in space or different in composition) contained the same fossils, chances were good that they had been laid down at the same time. Detailed studies of the strata and fossils of Europe produced, between 1820 and 1850, the sequence of geological periods still used today.

British geologists dominated the process, and the names of the periods reflect that dominance. The "Cambrian," "Ordovician," and "Silurian" periods were named after ancient British tribes (and defined using stratigraphic sequences from Wales). The "Devonian" was named for the English county of Devon, and the name "Carboniferous" was simply an adaptation of "the Coal Measures," the old British geologists' term for the same set of strata. The "Permian," though defined using strata in Russia, was delineated and named by a British geologist: Roderick Murchison.

British geologists were also responsible for the grouping of periods into Eras and the subdivision of the Tertiary and Quaternary periods into epochs.
Abridged from: http://microsoftencarta-in-english.blogspot.com/2008/12/geology.html

TEST 1

Variant 3

READING

I. Read the text and match the headings (1–4) with the paragraphs (A–D).

1. Aim of geological maps ____
2. Popularity of computer-based models ____
3. Peculiarities of subsurface maps ____
4. What is a "geological survey"? ____

GEOLOGICAL SURVEYS

A. A geological survey is the systematic investigation of the geology beneath a given piece of ground for the purpose of creating a geological map or model. Geological surveying employs techniques from the traditional walk-over survey, studying outcrops and landforms, to intrusive methods, such as hand augering and machine-driven boreholes, to the use of geophysical techniques and remote sensing methods, such as aerial photography and satellite imagery. Such surveys may be undertaken by state, province, or national geological survey organizations to maintain the geological inventory and advance the knowledge of geosciences for the benefit of the nation.

B. A geological survey map typically superimposes the surveyed extent and boundaries of geological units on a topographic map, together with information at points (such as measurements of orientation of bedding planes) and lines (such as the intersection of faults with the land surface). The maps and reports created by geological survey organizations generally aim for geographic continuity and completeness in establishing the spatial patterns of near-surface rock units. The map may include cross sections to illustrate the three-dimensional interpretation.

C. Subsurface geological and geophysical maps, providing limited coverage of deeper geology (known, for example, from drilling for oil or gas), are maintained internally by major oil companies and regulators. Some geological survey organisations have collaborated with them to include subsurface geology in their systematic surveys, for example, the Geological Atlas of the Western Canada Sedimentary Basin. Subsurface maps typically depict the three-dimensional form of geological surfaces by means of contours and cross sections.

D. Computer-based models are increasingly used to provide more comprehensive information storage and greater flexibility of presentation. In the United States, the 50 state surveys are coordinated by the Association of American State Geologists.

Abridged from: https://en.wikipedia.org/wiki/Geological_survey

II. Read about the fields of geology. Write whether the following statements are true (T) or false (F).

Statement	True/False (T/F)	
1. There are three main fields of geology: physical, historical and structural one.		
2. Physical geology cannot be subdivided into a number of further disciplines such as petrology or mineralogy.		
3. Rocks are made of minerals.		
4. Mineralogy is important for such a materials engineering branch as ceramics.		
5. Petrology focuses on three rock types – sedimentary, igneous and metamorphic ones.		
6. Neotectonics is useless for land-use planning and hazard analysis.		

FIELDS OF GEOLOGY

Geologists have found it useful to divide geology into two main fields: *physical geology*, which examines the nature of the Earth in its present state; and *historical geology*, which examines the changes the Earth has undergone throughout time.

Physical geology can be subdivided into a number of disciplines according to the way geologists study the Earth and which physical aspects they study.

The fields of *mineralogy* (the study of minerals) and *petrology* (the study of rocks) are closely related, because rocks are made of minerals. Mineralogists and petrologists study the origin, occurrence, structure and history of rocks and minerals. They attempt to understand the physical, chemical and less commonly, biological conditions under which geologic materials form. Mineralogy is important for understanding natural materials and is also used in the materials engineering field, such as in ceramics. Petrology focuses on two of the three rock types: igneous rocks – rocks made from molten material, and metamorphic rocks – those rocks that have been changed by high temperatures or pressures. The third rock types, sedimentary rocks, are the focus of sedimentary geology, commonly classified under historical geology.

Structural geology deals with the form, arrangement and internal structure of rocks, including their history of deformation, such as folding and faulting. Structural geology includes everything from filed mapping to the study of microscopic deformation within rocks. Most geologic reconstructions require an understanding of structural geology. The term *tectonics* is commonly used for large-scale structural geology, such as the study of the

history of a mountain belt, or plate tectonics (the study of the crustal plate). *Neotectonics* is the study of recent faulting and deformation; such studies can reconstruct the history of active faults, and the history can be used in hazard analysis and land-use planning.

Abridged from: https://www.britannica.com/science/geology/Study-of-the-structure-of-the-Earth

III. Read the text QUARTZ and answer the questions.

1. What is quartz?
2. Where does it mostly occur?
3. What is chalcedony?
4. What are the other wide-spread varieties of qurtz?
5. What intensifies the colour of quartz varieties?
6. What is the colour of a layer that hematite forms internally in a quartz crystal?
7. What are the inner and outer layers of geodes?

QUARTZ

Quartz is one of the most well-known minerals on earth. It occurs in basically all mineral environments, and is the important constituent of many rocks. Quartz is also the most varied of all minerals, occurring in all different forms, habits, and colors. There are more variety names given to quartz than any other mineral. Although the feldspars as a group are more prevalent than quartz, as an individual mineral quartz is the most common mineral.

Most mineral reference guides list chalcedony as an individual mineral, but in reality it is a variety of quartz. It is the microcrystalline form of quartz, forming only occurs in microscopic, compacted crystals. Amethyst, citrine, and agate can be enumerated among the other important varieties of quartz.

Some forms of quartz, especially, the gemstone forms, have their color enhanced. Almost all forms of the yellow-brown variety citrine are in fact heat treated. Much amethyst is also heat treated to intensify color, and a green transparent form known as "Green Amethyst" or "Prasiolite" is formed by heat treating certain types of amethyst. There is also a transparent sky blue form of quartz crystals as well as a wildly iridescent type that are synthetically colored by irradiation of gold. In some localities, hematite forms a thin red or brown layer internally in the quartz crystal, giving it a natural bright red to brown coloring, and sometimes even a mild natural iridescence.

Quartz frequently forms the inner lining of geodes. Most geodes have an inner layer of larger crystalline quartz and an outer layer of chalcedony or banded agate.

Abridged from: https://www.minerals.net/mineral/quartz.aspx

VOCABULARY AND TERMINOLOGY

IV. Read the text QUARTZ in detail and match the words and word-groups (1–10) with their translations (a–j).

1)	mineral environment	a)	усиливать
2)	feldspars	b)	радужный
3)	gemstone	c)	облучение
4)	heat treating	d)	жеода, миндалевидная пустова
5)	transparent	e)	драгоценный (цветной) камень
6)	iridescent	f)	минеральная среда
7)	irradiation	g)	полосчатый агат
8)	geode	h)	тепловая/термическая обработка
9)	banded agate	i)	прозрачный, просвечивающий
10)	to intensify	j)	полевой шпат

V. Read the text FIELDS OF GEOLOGY in detail and choose the correct variant a, b, c or d.

1. What are two main fields of geology?
   a) physical and structural
   b) physical and historical
   c) mineralogy and petrology
   d) mineralogy and paleontology
2. The fields of mineralogy and petrology are _____.
   a) related, but not closely
   b) not related at all
   c) absolutely different
   d) closely related
3. Petrology focuses on two types of rocks:
   a) sedimentary and metamorphic rocks
   b) igneous and sedimentary rocks
   c) igneous and metamorphic rocks
   d) metamorphic and hydrothermal rocks
4. The main aim of mineralogists and petrologists is to understand _____.
   a) biological conditions under which geologic materials formed
   b) history of geologic formation
   c) physical and chemical conditions under which materials formed
   d) how to use geologic materials
5. Neotectonics helps _____.
   a) to reconstruct the history of active faults
   b) to conduct measurements
   c) to extract deposits
   d) to conduct exploration on site

VI. For questions 1–5, choose one of the words (a–f) that best completes a gap in the text. You can use each word only once. There is one extra word.

a)	**scale**	**c)**	**cleavage**	**e)**	**hardness**
b)	**to obtain**	**d)**	**specimens**	**f)**	**property**

WHAT IS MOH'S HARDNESS SCALE?

One of the most important tests for identifying mineral 1) ____ is the Mohs Hardness Test. This test compares the resistance of a mineral to being scratched by ten reference minerals known as the Mohs Hardness 2) ____. The test is useful because most specimens of a given mineral are very close to the same 3) _____. This makes hardness a reliable diagnostic 4) ____ for most minerals.

Friedrich Mohs, a German mineralogist, developed the scale in 1812. He selected ten minerals of distinctly different hardness that ranged from a very soft mineral (talc) to a very hard mineral (diamond). With the exception of diamond, the minerals are all relatively common and easy or inexpensive 5) _____.

VII. Fill in the gaps with the given derivatives.

explore exploration exploring explored exploratory

1. This is based on experience and on our practices in _____ that part of the continental shelf.
2. Our team has made a decision about where _____ for oil.
3. WYO has been undertaking _____ and analytical work since then.
4. Hydrocarbon _____ is the search for hydrocarbon deposits beneath the Earth's surface.
5. Additional options should be _____.

VIII. Complete the summary of the text QUARTZ. Use only one word in each sentence.

1. Quartz is one of the most well-known _____ on earth.
2. It is an important _____ of many rocks.
3. Also it is the most varied of all minerals, occurring in different forms, habits and _____.
4. Amethyst, citrine and agate can be _____ among the other important varieties of quartz.
5. Some forms of quartz, especially, _____ forms have their colour enhanced.
6. A green transparent form known as "Prasiolite" is formed by _____ treating certain types of amethyst.
7. Quartz frequently forms the inner _____ of geodes.

GRAMMAR

IX. Rewrite the following sentences in Passive.

1. By six o'clock they had finished the work.
2. At twelve o'clock the workers were loading the trucks.
3. We send our workes to rest in the south every year.
4. They are building a new building in our street.
5. We shall bring the documents tomorrow.
6. They are repairing the clock now.
7. I have translated the whole text.
8. They broke the window last week.
9. When I came home, they had eaten the sweets.
10. We shall do the work in the evening.

X. Open the brackets and put the verbs in the required passive form. Mind the tense and preposition.

1. The application of these mining methods often (to refer to).
2. The process of extracting lead from this ore (to object to) at the recent conference.
3. The statistical theory (to develop) quite recently.
4. Objects with negative stability usually (to call) unstable.
5. These classifications already (to use).
6. Cooling often (to provide) by the circulation of water.
7. Some pressing problems (to discuss) at the symposium next week.
8. The new discovery (to speak about) now.
9. The scientists understood that a more careful approach (to need) to realize their idea in future.
10. The explorers (to see) not far from the camp of the expedition yesterday.

TRANSLATION

XI. Find 10 sentences with the Passive Voice in the texts of Variant 3. Write them down and translate into Russian.

WRITING

XII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176)

WHAT ARE REEs?

REEs or Rare earth elements are a group of seventeen chemical elements that occur together in the periodic table. The group consists of yttrium and the 15 lanthanide elements (lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium). Scandium is found in

most rare earth element deposits and is sometimes classified as a rare earth element. The International Union of Pure and Applied Chemistry includes scandium in their rare earth element definition.

The rare earth elements are all metals, and the group is often referred to as the "rare earth metals". These metals have many similar properties, and that often causes them to be found together in geologic deposits. They are also referred to as "rare earth oxides" because many of them are typically sold as oxide compounds.

Rare earth metals and alloys that contain them are used in many devices that people use every day such as computer memory, DVDs, rechargeable batteries, cell phones, catalytic converters, magnets, fluorescent lighting and much more.

During the past twenty years, there has been an explosion in demand for many items that require rare earth metals. Twenty years ago there were very few cell phones in use, but the number has risen to over 7 billion in use today. The use of rare earth elements in computers has grown almost as fast as cell phones.

Many rechargeable batteries are made with rare earth compounds. Demand for the batteries is being driven by demand for portable electronic devices such as cell phones, readers, portable computers, and cameras.

Rare earths are used as catalysts, phosphors, and polishing compounds. These are used for air pollution control, illuminated screens on electronic devices, and the polishing of optical-quality glass. All of these products are expected to experience rising demand.

Abridged from: https://geology.com/articles/rare-earth-elements

TEST 1

Variant 4

READING

I. Read the text and match the headings (1–4) with the paragraphs (A–D).

1. Chemical erosion ____
2. Causes and types of erosion ____
3. Physical erosion ____
4. What is "erosion"? ____

EROSION

A. Erosion is the geological process in which earthen materials are worn away and transported by natural forces such as wind or water. A similar process, weathering, breaks down or dissolves rock, but does not involve movement.

B. Most erosion is performed by liquid water, wind, or ice (usually in the form of a glacier). If wind is dusty, or water or glacial ice is muddy, erosion is taking place. The brown color indicates that bits of rock and soil are suspended in the fluid (air or water) and being transported from one place to another. This transported material is called sediment. The process of erosion is often broken down into two forms: physical erosion and chemical erosion. They often work together, as well as with other geological processes such as weathering and sedimentation.

C. Physical erosion describes the process of rocks changing their physical properties without changing their basic chemical composition. Physical erosion often causes rocks to get smaller or smoother. Rocks eroded through physical erosion often form clastic sediments. Clastic sediments are composed of fragments of older rocks that have been transported from their place of origin. Landslides and other forms of mass wasting are associated with physical weathering. These processes cause rocks to dislodge from hillsides and crumble as they tumble down a slope. Plant growth can also contribute to physical erosion in a process called bioerosion. Plants break up earthen materials as they take root, and can create cracks and crevices in rocks they encounter.

D. Chemical erosion describes the process of rocks changing their chemical composition as they erode. Chemical erosion almost always refers to rocks interacting and undergoing a chemical reaction with water. The most familiar form of chemical erosion is probably rust, the product of a process called oxidation. During oxidation, rocks interact with oxygen in the presence of water. The amount of water required for oxidation is minimal, often the amount of water present in the atmosphere. Iron is the most familiar minera to undergo oxidation and rust.

Abridged from: https://www.nationalgeographic.org/encyclopedia/erosion/

II. Read about the sea floor. Write whether the following statements are true (T) or false (F).

Statement	True/False (T/F)	
1. Oceanic trenches are the locations of lithosphere plates that move under mobile plates.		
2. Most trenches lie around the rim of the Atlantic Ocean.		
3. Earthquakes generate as a result of injecting a cool material into the hot mantel rock below.		
4. Sediments are deformed when the subducted oceanic crust descends.		
5. The examples of island arcs can be found near Japan.		
6. The Andes were formed from volcanoes.		

HOW SEA FLOOR DISAPPEARS

While new sea floor grows outward from the spreading ridges, old sea floor disappears elsewhere, subducted – drawn down – into the mantle. Oceanic trenches are the sites of theses subduction zones where leading edges of lithosphere plates plunge under less dense or less mobile plates and so below a continent or ocean floor. Most trenches lie around the rim of the Pacific Ocean. Here vanish rocks originating from the spreading ridge that runs from Canada to south of New Zealand.

Subducted oceanic crust injects a tongue of a relatively cool material into the hot mantle rock beneath. The friction of its passage generates earthquakes.

As the subducted oceanic crust descends, its load of low-density sediments is largely scraped off and deformed. Meanwhile, 60 mi (100 km) down, the sinking lithosphere begins to melt; and 430 mi (700 km) down it has completely broken up.

Less dense than the surrounding mantle, molten matter from subducted lithosphere bobs up again. This molten rock melts holes through the edge of the plate above the one subducted. Together with the scraped-off sediments, this process builds island arcs – rows of volcanic islands curved because they form upon the Earth's curved surface. Examples of such arcs occur in the Aleutian, Japanese, Kurile and Cycladic Islands.

Oceanic crust subducted below a continental rim throws up volcanoes on the mainland. Volcanoes formed this way crown the Andes mountain chain of western South America.

Abridged from: Lambert. The Field Guide to Geology. Cambridge University Press, 1988.

III. Read the text EARTH CRUST and answer the questions.

1. Is the Earth's surface static or mobile?
2. Where does this activity take place?

3. What happens with the continents of our planet?
4. What do we call “asthenosphere”?
5. Which crust has bigger density: a continetntal or an ocean one?
6. What happens if two continents are brought together?
7. What is the example of this phenomenon?

EARTH CRUST

The Earth is not static. The forces that shape its surface are at work all the time, slowly heaving up the mountains and just as slowly wearing them away. The Earth’s crust is constantly being destroyed and renewed – not just the rocks of the continents, but the entire outer covering of the globe.

All this activity takes place on the floor of the oceans. Throughout the oceans there is a system of ridges. These are the places where the new surface material is being created. There are places where the surface material is being drawn down and destroyed. The continents are sitting embedded in these moving plates and are being shuffled around by the movement all the time.

The material of these plates consists of the crust and the topmost solid layer of the mantle, which together are called the lithosphere. They move about on a spongy region of the mantle, which we call the asthenosphere. The newly formed plate material makes up the ocean floor and so nowhere on the Earth’s surface is the ocean floor more than about 200 million years old.

The continental crust (sial) is less dense than the ocean crust (sima) and so it tends to float in it. It is too light to be drawn downward into the mantle and so when the continent is carried to an ocean trench it stays there, crumpling up with the continuing movement. This is the reason for the active mountain chains that we find at the edges of some continents.

When two continents are brought together they fuse into one supercontinent, uplifting a massive mountain range along the joint. The Himalayas are an example of such a range that is now being formed. The Urals represent one that was formed 300 million years ago and is now being worn away. The theory that oceanic is continuously being created and destroyed, and continents shift about sounds plausible is the evidence.

Abridged from: Lambert. The Field Guide to Geology. Cambridge University Press, 1988.

VOCABULARY AND TERMINOLOGY

IV. Read the text EARTH CRUST in detail and match the words and word-groups (1–10) with their translations (a–j).

1)	Earth crust	a)	астеносфера
2)	outer covering	b)	пористый (губчатый)
3)	ridge	c)	сиаль, континентальная оболочка
4)	spongy	d)	океанический желоб

5)	asthenosphere	e)	сминаться, раздавливаться
6)	sial	f)	край, кромка
7)	sima	g)	земная кора
8)	ocean trench	h)	сима, симпатическая оболочка
9)	edge	i)	наружная оболочка
10)	to crumple up	j)	горный хребет

V. Read the text EARTH CRUST in detail and choose the correct variant a, b, c or d.

1. According to the text, lithosphere can be better described as _____?
   a) a spongy region
   b) a soft region
   c) a solid layer
   d) a floation plate
2. The Earth is _____.
   a) static
   b) non static
   c) renewing
   d) unstable
3. According to the text, sial is ____.
   a) less dense than sima
   b) the same as sima
   c) approximately the same as sima
   d) denser than sima
4. The word "plausible" means ____.
   a) true
   b) reasonable
   c) probably
   d) specious
5. The age of the Hymalayas and the Urals are _____.
   a) the same
   b) different
   c) equal
   d) opposite

VI. For questions 1–5, choose one of the words (a–f) that best completes a gap in the text. You can use each word only once. There is one extra word.

a)	**asthenosphere**	**c)**	**earthquakes**	**e)**	**hardness**
b)	**processes**	**d)**	**lithosphere**	**f)**	**pressure**

PLATE TECTONICS

Plate tectonics are the unifying theory of geology. It was established in the 1960's, making it one of the most recent revolutions in all science. The theory describes the 1) ____ (the outer rocky layer of the earth) as a collection of rigid plates that move sideways above a less rigid layer called the 2) ____. The asthenosphere is made up of rock that is under tremendous 3) ____, which softens it and allows it to move and circulate slowly. Plate tectonics are useful in the field of geology, because it can be used to explain a variety of geologic 4) ____, including volcanic activity, 5) ____ and mountain building.

VII. Fill in the gaps with the given derivatives.

produce production product producing productive

1. Burundi has been exporting minerals that it does not _____.
2. Petroleum coke is a side _____ obtained in the process of petroleum refining.
3. Here is the list of countires dealing with iron ore _____ based on U.S. Geological Survey data.
4. Other countries are still debating the opportunity costs of _____ shale gas.
5. We wish you a very serious and _____ session.

VIII. Complete the summary of the text EROSION. Use only one word in each sentence.

1. Erosion is the _____ process, in which the earthen materials are worn away by natural forces such as wind or water.
2. Most erosion is performed by liquid _____, wind, or ice.
3. Bits of rock are _____ one place into another.
4. Transported material is called _____.
5. The process of erosion often includes two forms: a physical and _____ erosion.
6. Physical erosion describes the process of rocks changing their physical _____ without changing their chemical composition.
7. Chemical erosion almost always refers to rocks _____ and undergoing a chemical reaction with water.

GRAMMAR

IX. Rewrite the following sentences in Passive.

1. He wrote this book in the 19th century.
2. They were playing tennis from four till five.
3. They have made a number of important experiments in this laboratory.
4. Livingstone explored Central Africa in the 19th century.
5. By the middle of autumn we had planted all the trees.

6. They will stage this play at the beginning of next season.
7. They have forgotten the story.
8. Has anybody explained the rules of the game to you?
9. They haven't brought back my skates.
10. By three o'clock the workers had loaded the trucks.

X. Open the brackets and put the verbs in the required passive form. Mind the tense and preposition.

1. System effectiveness usually (to identify and to evaluate) through tests and experiments which often (to perform) during the planning, research, design, production.
2. No matter how well objectives (to define), how much planning (to do), or how expert the personnel may (to be), unexpected problems will inevitably occur which threaten the success of the test or experiment.
3. Numerous classifications recently (to use).
4. The large disagreement between the various published data (to discuss) at tis moment.
5. Some of the data obtained cannot (to rely upon).
6. Newton's laws of motion may (to subject) to criticism.
7. The first discovery (to follow) by many others some years ago.
8. The conference (to attend) by twenty seven astronomers last week.
9. The changes taking place (to account for) not easily.

TRANSLATION

XI. Find 10 sentences with the Passive Voice in the texts of Variant 4. Write them down and translate into Russian.

WRITING

XII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176)

GEOLOGIC CYCLES

A second guiding principle of geology is the principle of recycling materials, or using materials many times. All processes in geology can be viewed as a series of mostly closed cycles, meaning the materials of the cycles are found on earth, and a very few materials from outside our world are introduced into these cycles. The energy that drives geologic recycling comes from two resources: the sun and the earth's interior. Two examples of geologic cycles are the rock cycle and the water cycle.

The **rock cycle** begins as rocks are uplifted or pushed up by tectonic forces. The exposed rocks erode as a result of surface processes, such as rain and wind. The eroded particles or sediments travel by wind or moving water

until they are deposited and the deposited material settles into layers. Additional sediment may bury these layers until heat and pressure metamorphose or change the underlying sediment to metamorphic rock. Additional sediment may compact the layers into sedimentary rocks. Rocks can also be subducted (sunk down into the lower layers of the Earth) by tectonic processes. Buried and subducted rocks may also melt and crystallize into igneous rocks. Metamorphic, sedimentary and igneous rocks may then be uplifted, starting the rock cycle again.

The **water cycle** is also known as the hydrologic cycle. Phases of water cycle are storage, evaporation, precipitation and runoff. Water is stored in glaciers, polar ice caps, lakes, rivers, oceans and in the ground. Heat from the sun evaporates water from the Earth's surface and the water then condenses to form clouds. It falls back to the earth as precipitation. Either as rain or snow, then runs into the oceans through rivers or underground and begins the cycle again.

Abridged from: http://spxelementary.com/userfiles/1001/Rock_Cyle_Notes.pdf

TEST 1

Variant 5

READING

I. Read the text and match the headings (1–4) with the paragraphs (A–D).

1. Core composition ____
2. A hard-boiled egg ____
3. Core structure ____
4. Secret of the Earth centre ____

WHAT IS IN THE CENTRE OF THE EARTH?

A. The first thing to remember is that NOBODY has ever been there, so what you are about to hear is barely past the Wild and Crazy Idea stage. What we think we know comes from a study of how earthquake (seismic) waves travel through the earth, and how long it takes for them to get from where the earthquake happens to a recording station. The basic idea is that different materials transmit seismic waves at different speeds. With a lot of earthquakes and a lot of recording stations, geophysicists are beginning to get a pretty detailed picture of what is probably down there.

B. One of the most distinctive features of the Earth's interior is how it seems to be layered by density, with the heaviest stuff in the center, and the lightest material at the surface. In fact, the Earth probably looks a lot like a hard-boiled egg if you could cut it open. The yellow stuff in the center (the yolk) relates to what we call the core.

C. Most geophysicists think that the core is composed of high-density materials like iron and nickel. The egg's shell is like the Earth's crust – a thin veneer of rigid, low-density material at the surface. And all the white stuff in between is like the Earth's mantle – the largest layer that, in the case of the Earth, is of medium density, and, in the case of an egg, tastes best with a bit of salt and pepper.

D. The core seems to be in two parts – a "solid" inner core with a "liquid" outer layer – and is the final resting place for as much of the high-density material as can get there. The crust is REAL thin relative to the size of the Earth – much, much thinner than an eggshell, and is of much lower density than the core. It is probable that the mantle represents the vast majority of the Earth's mass, which is still trying to figure out if it is heavy enough to be accepted at the core, or is lower in density and therefore has to float about on the surface with the rest of the scum.

Abridged from: Paul Nixon & Alfredo Bezzi. English for Geologists,1998.

II. Read about igneous rocks. Write whether the following statements are true (T) or false (F).

Statement	True/False (T/F)	
1. The best known type of igneous rocks is lava.		
2. When magma reaches the surface of the Earth, it cools much more slowly.		
3. Igneous rocks show that the Earth is still changing and constantly rebuilding its mountains and hillsides.		
4. Little magma cools below the Earth's surface.		
5. Igneous rocks are formed from melted materials.		
6. Igneous rocks have nothing common with active volcanoes.		

IGNEOUS ROCKS

Igneous rocks are those which are formed from melted or molten materials. Igneous rocks were once magma – a thick, hot liquid deep inside the earth. The crust contains two distinct types of rocks. The continents are supported by the crystalline sial (abbreviation for silicon and aluminum). Sial rocks are light in color and light in weight. They are the rocks that form our great mountain ranges. Lying underneath the sial is the sima (abbreviation for silica and magnesium). Volcanic lavas are of silica-magnesium type. They are dark rocks and are generally heavier than those of the sial.

Earth movements create zones of weakness. This permits some of the magma to find its way up into the crust. Sometimes magma moves to the surface, spewing out of volcanoes or spreading over the countryside in huge lava flows. Lava is only one type of igneous rock, but it's probably the best known. Most magma cools below the surface of the earth. Under these conditions it cools very slowly.

Inside the crust, magma may flow into branching cracks forming veins. It may cut across layers of rock forming great sheets-like dikes. When magma flows between layers it forces the rock apart. Such intrusion is known as a sill. When magma reaches the earth's surface it cools much more rapidly. The rock it forms is then called an extrusive rock because it is pushed out into the surface.

Igneous rocks were the first kind of rocks to form. Some are known to be over two billion years old. At the same time, some other igneous rocks are the youngest rocks, for there are active volcanoes still spewing lava from their craters this very day. Igneous rocks offer proof that the earth is still growing, changing and constantly rebuilding its mountains and hillsides.

Abridged from: https://www.nationalgeographic.org/encyclopedia/magma/

III. Read the text WHAT IS A FLUORESCENT MINERAL and answer the questions.

1. What is "fluorescence"?
2. What causes a temporary colour change of the mineral?
3. What types of light trigger fluorescence?
4. How many minerals have a noticeable fluorescence?
5. Do impurities help to activate fluorescence or not? How are they called?
6. How many colours can minerals fluoresce?
7. How do shortwave and longwave UV light influences minerals?

WHAT IS A FLUORESCENT MINERAL?

All minerals have the ability to reflect light. That is what makes them visible to the human eye. Some minerals have an interesting physical property known as "fluorescence." These minerals have the ability to temporarily absorb a small amount of light and an instant later release a small amount of light of a different wavelength. This change in wavelength causes a temporary color change of the mineral in the eye of a human observer.

Fluorescence in minerals occurs when a specimen is illuminated with specific wavelengths of light. Ultraviolet (UV) light, x-rays, and cathode rays are the typical types of light that trigger fluorescence. These types of light have the ability to excite susceptible electrons within the atomic structure of the mineral. These excited electrons temporarily jump up to a higher orbital within the mineral's atomic structure. When those electrons fall back down to their original orbital, a small amount of energy is released in the form of light. This release of light is known as fluorescence.

The wavelength of light released from a fluorescent mineral is often distinctly different from the wavelength of the incident light. This produces a visible change in the colour of the mineral. This "glow" continues as long as the mineral is illuminated with light of the proper wavelength.

Most minerals do not have a noticeable fluorescence. Only about 15 % of minerals have a fluorescence that is visible to people, and some specimens of those minerals will not fluoresce. Fluorescence usually occurs when specific impurities known as "activators" are present within the mineral. These activators are typically cations of metals such as: tungsten, molybdenum, lead, boron, titanium, manganese, uranium, and chromium.

Most minerals fluoresce a single colour. Other minerals have multiple colours of fluorescence. Calcite has been known to fluoresce red, blue, white, pink, green, and orange. Some minerals are known to exhibit multiple colors of fluorescence in a single specimen. These can be banded minerals that exhibit several stages of growth from parent solutions with changing composi-

tions. Many minerals fluoresce one colour under shortwave UV light and another color under longwave UV light.
Abridged from: https://geology.com/articles/fluorescent-minerals

VOCABULARY AND TERMINOLOGY

IV. Read the text WHAT IS A FLUORESCENT MINERAL in detail and match the words and word-groups (1–10) with their translations (a–j).

1)	fluorescence	a)	свечение, сияние
2)	wavelength	b)	свинец
3)	specimen	c)	поглощать
4)	atomic structure	d)	примесь
5)	impurity	e)	люминесценция/флюоресценция
6)	chemical composition	f)	длина волны
7)	lead	g)	образец
8)	glow	h)	отражать
9)	to absorb	i)	атомная структура
10)	to reflect	j)	химический состав

V. Read the text WHAT IS A FLUORESCENT MINERAL in detail and choose the correct variant a, b, c or d.

1. According to the text, all the minerals have the ability_____.
   a) to absorb water
   b) to reflect light
   c) to be dissolved
   d) to break into pieces
2. Changes in wavelengths cause _____.
   a) a temperature change
   b) a chemical composition change
   c) a weight change
   d) a temporary colour change
3. How many minerals have the fluorescence that is visible to people?
   a) 90 %
   b) 35 %
   c) 15 %
   d) 50 %
4. Fluorescence occurs when a mineral has ____.
   a) cracks
   b) impurities
   c) cleavage
   d) water inside

5. Irradiation with shortwave and longwave UV light influences ____.
   a) the shape of a mineral
   b) the colour of a mineral
   c) the composition of a mineral
   d) the age of a mineral

VI. For questions 1–5, choose one of the words (a–f) that best completes a gap in the text. You can use each word only once. There is one extra word.

a)	**biochemistry**	**c)**	**hydrosphere**	**e)**	**application**
b)	**reconstructing**	**d)**	**petrology**	**f)**	**pressure**

GEOCHEMISTRY

Geochemistry is the 1) ____ of chemistry to the study of the Earth, its materials and the cycling of chemicals through its systems. It is essential in numerical dating and in 2) ____ past conditions on the Earth. Geochemistry is important for tracing the transport of chemicals through the Earth's four component systems: the lithosphere (rocky exterior), the 3) ____ (waters of the Earth), the atmosphere (air) and the biosphere (the system of living things). 4) ____ is an emerging field that examines the chemical interactions between living and nonliving systems – for example, microorganisms that act in soil formation. Geochemistry has important applications in environmental and economic geology as well as in the fields of mineralogy and 5) ____ .

VII. Fill in the gaps with the given derivatives.

transport (2) transportation transporting transported

1. Our government starts a new project " _____ and Environment".
2. Be careful! These vehicles were used for _____ ammonia.
3. A good example among _____ dangerous goods is metallic mercury.
4. Publc _____ in this city is insufficient but it is improving.
5. Investments in the main oil _____ line should go first.

VIII. Complete the summary of the text IGNEOUS ROCKS. Use only one word in each sentence.

1. Igneous rocks are those which are formed from _____ or molten materials.
2. The crust contains two distinct types of _____.
3. _____ rocks are light in colour and light in weight.
4. Volcanic lavas are of _____ type, these rocks are dark and heavy.
5. Earth movements create the zones of _____ where magma moves to the surface.
6. When magma reaches the Earth's surface, it _____ rapidly.
7. Igneous rocks give proof that the Earth is still _____ and constantly rebuilding its mountains and hillsides.

GRAMMAR

IX. Use the required form of the verb in the Passive voice.

1. The roads (to cover) with the snow. – Дороги покрыты снегом.
2. Chocolate (to make) from cocoa. – Шоколад изготавливается из какао.
3. The Pyramids (to build) in Egypt. – Пирамиды были построены в Египте.
4. This coat (to buy) four years ago. – Это пальто было куплено 4 года назад.
5. The stadium (to open) next month. – Стадион будет открыт в следующем месяце.
6. Your parents (to invite) to a meeting. – Твои родители будут приглашены на собрание.
7. Where is your car? – It (to mend) at the moment. – Где твоя машина? – В данный момент она ремонтируется.
8. The books already (to pack). – Книги уже упакованы.
9. The castle can (to see) from a long distance. – Замок можно увидеть издалека.
10. The guests must (to meet) at noon. – Гости должны быть встречены в полдень.

X. Write out the sentences containing the Passive voice. Define the tense form of the verbs in the passive voice.

1. Owing to its light weight and high melting point this mineral has been used by scientists.
2. These materials have been available for over a decade.
3. He made up a detailed map of the Asian part of our country.
4. In the last twenty years remarkable advances have been made in the development of science and technology.
5. This person is regarded as the founder of modern geology.
6. Endogenous forces can result in formation of new rocks.
7. The term "geology" has been applicable to the Earth as a whole.
8. Regional geology aims at the integration of all the geological information pertaining to a particular area.
9. Geology is subdivided into several specialized disciplines.
10. The Earth’s crust is constantly subjected to vertical and horizontal movements.
11. Karpinsky was a member of many Academies abroad.
12. V.I. Vernadsky is known as the outstanding mineralogist.
13. Many research centers were established by this scientist.
14. He conducted experiments in the geochemistry of rare elements.
15. The role of such minerals as radium and uranium was forecasted by him.

TRANSLATION

XI. Find 10 sentences with the Passive Voice in the texts of Variant 5. Write them down and translate into Russian.

WRITING

XII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176)

THEORY OF CONTINENTAL DRIFT

In 1910 American geologist Frank B. Taylor proposed that lateral (sideways) motion of continents caused mountain belts to form on their front edges. Building on this idea in 1912, German meteorologist Alfred Wegener proposed a theory that came to be known as Continental Drift. He proposed that the continents had moved and were once part of one, large supercontinent called Pangaea. Wegener was attempting to explain the origin of continents and oceans, when he expanded upon Taylor's idea. His evidence included the shapes of continents, the physics of ocean crust, the distribution of fossils and paleoclimatology data.

Continental drift helped to explain a major issue of the 19th century: the origin of mountains. Theories commonly called on the cooling and contracting of the Earth to form mountain chains. The mountain-building theories of German geologist Leopold von Buch and French geologist Leonce Elie de Beaumont were catastrophic in nature. American geologist James Dwight Dana proposed the geosynclinal theory of mountain building – a theory based on the downward bending of the Earth's crust (a geosyncline). Austrian geologist Eduard Suess developed a related theory. Hall, Dana and Suess believed that continents and ocean basins were ancient, permanent features on earth and that mountain belts formed at their edges.

Most geologists did not accept the theory of continental drift in the 1920s and 1930s. British geologist Arthur Holmes supported continental drift and proposed that convection (a type of heat movement) inside the Earth drove continental drift. Other scientists, such as British geophysicist Harold Jeffreys, argued that continental drift was physically impossible. Paleontologists, such as American George Gaylord Simpson, said that the distribution of fossils could be explained by other means.

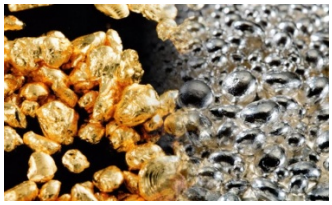
Abridged from: https://answers.yahoo.com/question/index?qid=20070216064817AAD5ioI&guccounter=1

Unit 3

MINING ENGINEERING

LEAD-IN

Match the words in bold with the pictures a-g.

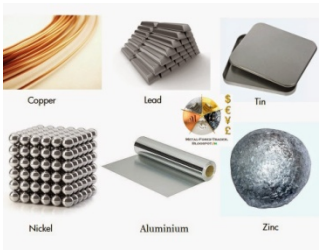


a

b

c

d



e

f

g

Mining is the extraction of valuable minerals or other geological materials from the earth, usually from an ore body, vein or (coal) seam. Materials recovered by mining include **base metals**, **precious metals**, **iron**, **uranium**, **coal**, **diamonds, limestone** and etc.

I. Read and remember the list of words associated with Mining Engineering.

1)	access	– доступ
2)	to affect	– воздействовать (на что-л.); влиять;
3)	barren	– непродуктивный;пустой (*о породе*)
4)	capital investment	– капиталовложения
5)	chute	– скат, спуск; углеспускная выработка; жёлоб
6)	to compare	– (with) сравнивать, проводить параллель

7) to contribute – способствовать, содействовать; делать вклад (*в науку*); make a (one's) ~ to smth. сделать вклад во что-л.
8) cross-section – поперечное сечение, поперечный разрез, профиль
9) to develop – разрабатывать *(месторождение*); развивать (*добычу*); производить подготовительные работы
development – подготовительные работы; развитие добычи; развитие
10) development work – техническая/технологическая разработка
11) drift – штрек, горизонтальная выработка
12) to ensure – обеспечивать, гарантировать
13) face – забой; лава
14) floor – почва горной выработки, почва пласта (жилы);
15) to govern – править, управлять; руководить; определять, обусловливать
16) inclination – уклон, скат, наклон (*пластов*); наклонение;
17) incline – уклон, бремсберг, скат; наклонный ствол; gravity ~ бремсберг
18) inclined – наклонный; flatly ~ слабо наклонный; gently ~ наклонного падения; median ~ умеренно наклонный (*о пластах*); steeply ~ крутопадающий
19) level – этаж, горизонт, горизонтальная горная выработка; штольня; уровень (*инструмент*); нивелир; ватерпас; горизонтальная поверхность
20) metallic mineral – полезные рудные ископаемые
21) mineral-bearing – содержащий минерал
22) mode of occurrence – условия залегания
23) non-metallic mineral – полезные нерудные ископаемые
24) ore extraction – добыча руды
25) production work – выработка; производительность
26) quarry – подошва карьера; пол, настил
27) to recover – извлекать (*целики*); выбирать, очищать; добывать (*уголь и т. п.*); восстанавливать
28) to remove – удалять; убирать; устранять; перемещать
29) removal – вскрыша; выемка;уборка (*породы*); извлечение (*крепи*); перемещение
30) rib – ребро; выступ; узкий целик, предохранительный целик; грудь забоя

31) roof – крыша; кровля выработки; кровля пласта (*или* жилы); перекрытие; ~ support крепление кровли
32) seam ~ падение (*пласта*); наклон (*пласта*)
33) shaft – шахтный ствол; auxiliary ~ вспомогательный ствол; hoisting ~ подъемный ствол; главный шахтный ствол
34) tabular – пластовый (о *месторождении*); пластообразный; плоский; линзообразный
35) waste – пустая порода; отходы
36) well – буровая скважина; колодец, источник; водоем; зумф

II. Read the following words and remember their pronunciation.

[ɔ:] broad, broadly, sought, floor, toward, call
[ou] process, coal, mode, slope, sloping
[i] pit, mineral, building, distance, driven
[i:] beneath, speaking, peat, increase
[Λ] production, productive, occurrence, recovery, govern, above, function
[ɔ] quarry, problem, economical, cross-section, crosscut
[æ] mass, tabular, barren, gas, shallow
[εə] compare, prepare, vary, various

III. Pay attention to the stress in the following words.

de'velopment	'process	ˌengi'neering
ˌincli'nation	in'dustrial	di'mension
de'posit	'ferrous	o'ccurrence
re'covery	tech'nique	'surface
re'search	in'cline	ˌobser'vation

READING

IV. Read the text and write whether the following statements are true (T) or false (F).

Statement		True/False (T/F)	
1.	Mining is the industrial process of removing a mineral-bearing substance from the place of its natural occurrence in the Earth's crust.		
2.	Mining can be done only as a surface operation.		
3.	Working or exploiting the deposit means the extraction of mineral.		
4.	Mine workings vary in shape, dimensions, location and function.		

Statement	True/False (T/F)	
5. Productive mining aims at ensuring access to the deposit from the surface.		
6. The surface above the workings is the roof in coal mining while in metal mining it is called the floor.		

General Information on Mining

Mining refers to actual ore extraction. Broadly speaking, mining is the industrial process of removing a mineral-bearing substance from the place of its natural occurrence in the Earth's crust. The term "mining" includes the recovery of oil and gas from wells; metal, non-metallic minerals, coal, peat, oil shale and other hydrocarbons from the earth. In other words, the work done to extract mineral, or to prepare for its extraction is called mining.

The tendency in mining has been towards the increased use of mining machinery so that modern mines are characterized by tremendous capacities. This has contributed to: 1) improving working conditions and raising labour productivity; 2) the exploitation of lower-grade metal-bearing substances and 3) the building of mines of great dimensions.

Mining can be done either as a surface operation (quarries, opencasts or open pits) or by an underground method. The mode of occurrence of the sought-for metallic substance governs to a large degree the type of mining that is practiced. The problem of depth also affects the mining method. If the rock containing the metallic substance is at a shallow site and is massive, it may be economically excavated by a pit or quarry-like opening on the surface. If the metal-bearing mass is tabular, as a bed or vein, and goes to a great distance beneath the surface, then it will be worked by some method of underground mining.

Working or exploiting the deposit means the extraction of mineral. With this point in view a number of underground workings is driven in barren (waste) rock and in mineral. Mine workings vary in shape, dimensions, location and function.

Depending on their function mine workings are described as exploratory, if they are driven with a view to finding or proving mineral, and as productive if they are used for the immediate extraction of useful mineral. Productive mining can be divided into capital investment work, development work, and face or production work. Investment work aims at ensuring access to the deposit from the surface. Development work prepares for the face work, and mineral is extracted (or produced) in bulk.

The rock surfaces at the sides of workings are called the sides, or in coal, the ribs. The surface above the workings is the roof in coal mining while in metal mining it is called the back. The surface below is called the floor.

The factors such as function, direct access to the surface, driving in mineral or in barren rock can be used for classifying mine workings:

I. Underground workings:

a) Long or deep by comparison with their cross-section may be: 1) vertical (shaft, blind pit); 2) sloping (slopes, sloping drifts, inclines); 3) horizontal (drifts, levels, drives, gate roads, adits, crosscuts).

b) Large openings having cross dimensions comparable with their length.

c) Production faces, whose dimensions depend on the thickness of the deposit being worked, and on the method of mining it.

II. Opencasts.

Abridged from: Barakova M.Ya., Zhuravleva R.I. English for mining engineers. Moscow, 2001.

V. Read a text about the main Mining industry segments. Match the industry segments below 1–5 with their descriptions A–E.

1. Coal mining segment
2. Nonmetallic mineral mining and quarrying
3. Support activities
4. Oil and gas extraction
5. Metal ore mining

The mining industry contains five main industry segments which are defined by the resources they produce: oil and gas extraction, coal mining, metal ore mining, nonmetallic mineral mining and quarrying, and support activities for mining.

A._____ produces the petroleum and natural gas that heat homes, fuel cars, and power factories. Petroleum products are also the raw materials for plastics, chemicals, medicines, fertilizers, and synthetic fibers. Petroleum, commonly called crude oil or just oil, is a liquid formed underground from the decay of plants and animals over millions of years through extreme heat and pressure. Occasionally, this decaying material becomes trapped under a layer of impermeable rock that prevents it from dispersing and creates a pocket of oil. Similar processes also produce natural gas, which can be found mixed with oil or in separate deposits. Finding and extracting the oil and gas in these pockets is the primary function of this industry segment.

B. _____ produces coal, a fossil fuel that is used primarily for electric power generation and in the production of steel. Like oil, coal is formed over millions of years from plant and animal matter, but unlike oil, coal is a solid and miners must go into the earth to recover it. Many coal seams are located close to the surface which makes the extraction of this resource easier.

C. _____ covers the extraction of metal ores, primarily gold, silver, iron, copper, lead, and zinc. These naturally occurring minerals have a variety of industrial purposes: gold and silver are primarily used in jewelry and high-end electronics; iron is used to produce steel; copper is the main component of electrical wiring; lead is used in batteries; and zinc is used to coat iron and steel to reduce corrosion and as an alloy in the making of bronze and brass. Most metals do not exist in concentrated form but rather in small traces in rock called "ore". Some ores are currently mined that contain only a fraction of a percent of metal. As a result, a massive amount of rock must be extracted from the ground in order to obtain a useable amount of metal. As a result of this, metal mines can be much larger than coal mines and operate in more extreme environments.

D. _____ covers a wide range of mineral extraction. The majority of the industry produces crushed stone, sand, and gravel for use in construction of roads and buildings. Other important minerals produced are clays, primarily for ceramics, water filtration, and cement making; gypsum, the primary material used in wallboard; salt, used in foodstuffs and as an ice remover; phosphate, for use in fertilizers; and sulfur, the main component of sulfuric acid, a major industrial input. Most of these minerals are found in abundance close to the surface.

E. _____. The activities of this industry are often the same as those of the other industry segments, but the work is done by contract companies that specialize in one aspect of resource extraction.

Abridged from: from www.wikipedia.org

VOCABULARY AND TERMINOLOGY

VI. Read the texts above in detail and match the English word-combinations (1–10) with the Russian equivalents (a–j).

1) direct access to the surface	a) открытая разработка
2) open-cast mining	b) проходить горные выработки по пустой породе
3) tabular (or bedded) deposits	c) влиять на метод разработки
4) production face	d) прямой доступ к поверхности
5) cross-section of a working	e) пластовые месторождения
6) underground workings	f) подземные выработки
7) mode of occurrence	g) условия залегания
8) the roof of the mine working	h) поперечное сечение выработки
9) to drive mine workings in barren rock	i) кровля горной выработки
10) to affect the mining method	j) очистной забой

VII. Choose the correct variant a, b or c.

1. The mining industry contains _____ main industry segments.
   a) 3
   b) 5
   c) 7
2. Finding and extracting the oil and gas in these pockets is the primary function of this industry segment.
   a) nonmetallic mineral mining and quarrying
   b) support activities
   c) oil and gas extraction
3. Metal ore mining deals with _____.
   a) a wide range of mineral extraction
   b) the petroleum and natural gas production
   c) the extraction of metal ores, primarily gold, silver, iron, copper, lead, and zinc
4. Coal is formed over millions of years from plant and animal matter, but unlike oil, coal is _____ and miners must go into the earth to recover it.
   a) solid
   b) liquid
   c) gaseous
5. Gold and silver are primarily used in _____.
   a) batteries
   b) electrical wiring
   c) jewelry and high-end electronics
6. To obtain useable metals, a massive amount of rock is extracted from the ground due to the fact that _____.
   a) most metals do not exist in concentrated form but rather in small traces
   b) most metals exist in concentrated form
   c) most metals are concentrated
7. The majority of the nonmetallic mineral mining industry produces _____ for use in construction of roads and buildings.
   a) crushed stone, sand, and gravel
   b) clays and gypsum
   c) crushed stone, phosphate and salt
8. _____ is the main component of sulfuric acid as well as a major industrial input.
   a) clay
   b) sulfur
   c) gypsum

VIII. Compose the sentences of the given words.

1. Done/mining/operation/can/be/by/either/as/a/underground/surface/or/an/method.
2. Depth/the/problem/also/mining/affects/the/of/method.
3. Means/working/mineral/extraction/or/the/exploiting/deposit/the/of.
4. Mine/location/workings/shape/and/vary/function/in/dimensions.
5. Aims/work/investment/at/to/ensuring/the/access/deposit/the/surface/from.
6. Development/prepares/work/work/for/the/face/and/extracted/mineral/is/in/bulk.

IX. Complete the following sentences with the words in bold in the text given below.

1. Dan studies _____ at the university.
2. The company uses _____ technology in a new way to create more efficient processes.
3. _____ is the exploitation of raw materials from asteroids and other minor planets including near-Earth objects.
4. The _____ of the new method is scheduled for next month.
5. The technology is _____, but may not be available for another decade.
6. _____ is a form of mining that uses high-pressure jets of water to dislodge rock material or move sediment.

Future in the Mining

There have been many developments in mining technology and methods over the past century. These have made it easier and safer to mine and process important materials. Today, engineers continue to make more advancements in mining technology and methods, which may change how we mine in the future.

Some of these advancements are improvements on how we already do things. For example, new tools have made **hydraulic mining** and rapid excavation attractive options for many companies. In addition, many mining companies use **existing** technology such as automation and **robotics** for tasks that would be dangerous for humans. In other cases, companies have found new uses for old techniques. For instance, some mining companies now use methods similar to borehole mining for methane drainage or underground gasification.

There are other advancements which are **promising**, but not quite ready for **implementation** at this point such as underground retorting and ocean mining. According to experts, these methods will not become more popular until the cost of using them drop significantly.

Finally, some engineers are researching **asteroid mining**. One way that asteroid mining would be beneficial is that it wouldn't harm the earth's environment. Furthermore, it could allow us to access minerals that are scarce on earth. However, at this point, asteroid mining is not possible.

Abridged from: Virginia Evans, Jenny Dooley, Kenneth Rodgers. Career Paths: Natural Resources II – Mining (Student's Book). Express Publishing, 2014

X. Match the words taken from the text above (1–8) with the definitions (a–h).

1) hydraulic mining	a) the conversion of coal to a gas while it is still underground
2) asteroid mining	b) the use of pressurized water to move rock and minerals
3) methane drainage	c) the mining of materials located under the ocean floor
4) ocean mining	d) the removal of oil from shale while it is still underground
5) underground retorting	e) a mining method that involves the continuous extraction of materials
6) underground gasification	f) the mining of asteroids
7) rapid excavation	g) the use of machines to perform tasks
8) automation	h) the removal of gas from coal seams by using boreholes or pipelines

GRAMMAR

Conditionals 0, 1, 2

Conditionals are clauses introduced with *if*. There are three types of conditional clause: Type 1, Type 2 and Type 3. There is also another common type, Type 0.

Type 0 Conditionals	They are used to express something which is always true. We can use *when* (*whenever*) instead of *if*	**E.g.** *If/ when the sun shines, snow melts*
Type 1 Conditionals	They are used to express real or very probable situations in the present or future	**E.g.** *If he doesn't study hard, he won't pass his exam*
Type 2 Conditionals	They are used to express imaginary situations which are contrary to facts in the present and, therefore, are unlikely to happen in the present or future	**E.g.** *If I won the lottery, I would buy an expensive car and I would go on holiday to a tropical island next summer*

(For more details you may see Grammar Reference p. 173).

XI. Match the Conditionals of 0/1/2 types (A–C) with the sentences (1–8).

Example: If you heat water, it boils. – Answer is. A. (Type 0 Conditionals)

A 0 type

B 1st type

C 2nd type

1. When water temperature reaches 100 degrees, this liquid always boils.
2. If the global temperature rises, sea levels will rise too.
3. If we dump all sorts of chemicals into rivers, we will not be able to swim in them in the future.
4. If the sun radiation can't escape into space, Earth's temperature will increase steadily.
5. If people weren't so careless, Earth wouldn't be in danger.
6. The amount of waste would decrease if people started to buy reusable packages.
7. We would be less worried if oil spills didn't have such destructive effects.
8. Experiment can happen only if both conditions exist.

XII. Underline the correct form to make conditional sentences.

1. If Rita *opens /will open* a boutique in the High Street, she'll make lots of money.
2. If the economy doesn't improve, lots of businesses *will close / would close* down.
3. George may go to prison unless he *won't pay / pays* his taxes.
4. The company *was / would be* more successful if it spent more money on advertising.
5. If the employees of a company *are/were* happy, they work harder.
6. We might sell our business if it *makes / would make* another loss this year.
7. It looks like Molly'll be okay, unless something new *will happen / happens*.
8. Mat *would not trust/ didn't trust* that unless he had to.

XIII. Open the brackets in the conditional sentences of type 1/ 2 and put the verbs in the correct form.

Example: *If it ___ (rain), we ___ (stay) at home. – If it rains, we shall stay at home.*

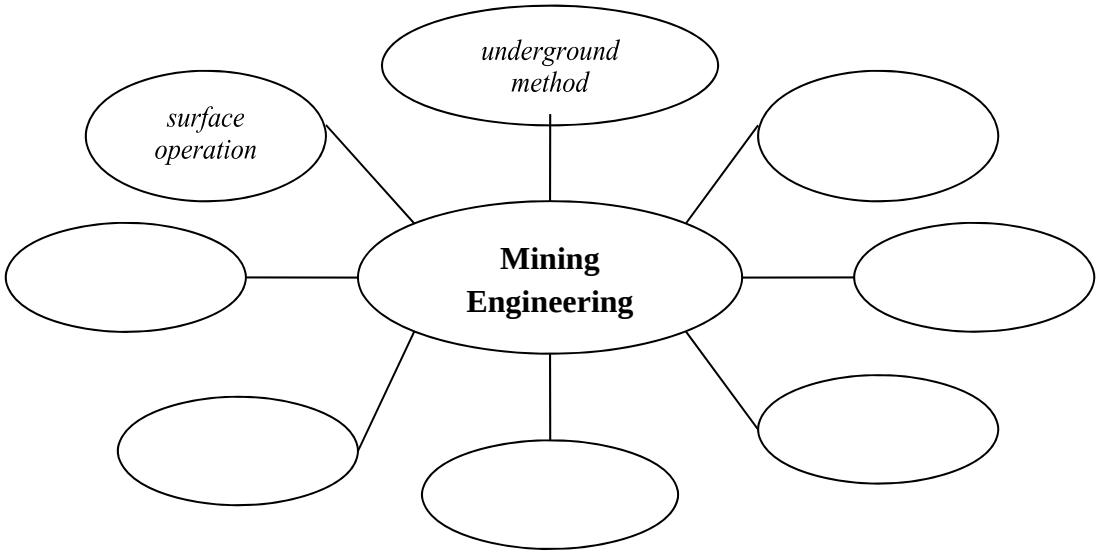
1. If he ___ (practice) every day, he ___ (become) a champion.
2. If you ___ (have) a driving license, you ___ (get) this job.
3. She ___ (help) us if we ___ (ask).
4. My dog ___ (be) 20 years old today if it ___ (be) alive.
5. If they ___ (have) enough money, they ___ (open) a restaurant next year.
6. I ___ (go) to the police if I ___ (be) you.
7. I ___ (not talk) to you anymore if you ___ (insult) me.
8. If people ___ (not buy) guns, the world ___ (become) safer.
9. If Bob ___ (not keep) his word, Anna ___ (be angry) with him.
10. Tom ___ (not eat) much "fast food" if his wife ___ (cook) at home.

TRANSLATION

XIV. Find 8 sentences with Conditionals 0, 1, 2 in the texts of Unit 3. Write them down and translate into Russian.

SPEAKING

XV. Fill in the spidergram with the words associated with Mining Engineering and explain your associations.



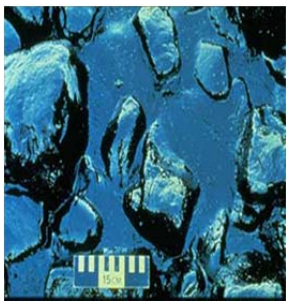
Example: *Mining can be done either as a surface operation or by an underground method.*

XVI. Match the words with mineral resources. Then using the information below describe these minerals and say where they can be applied.

uranium	**copper**	**gold**
coal	**petroleum**	**gravel**

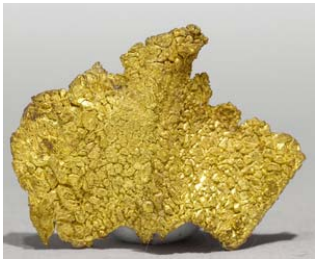
1

2



3

4



5

6

Description		
a black or brownish-black sedimentary rock	made up of a variety of rock fragments that vary in size	a silvery-grey radioactive metal
a precious metal that is often bright, slightly reddish yellow, dense, soft and malleable	a base metal of a reddish-orange color that is soft, malleable with very high thermal and electrical conductivity	yellow-to-black thick liquid found in geological formations beneath the Earth's surface

Application	
fuel for cars	jewellery
fuel for heating	electrical wiring
nuclear weapons	decorative material
fertilizers	road construction
nuclear power plants	electronics

For example:

Gold is a precious metal that is often bright, slightly reddish yellow, dense, soft and malleable. It is used in jewelry as well as a decorative metal.

WRITING

XVII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176).

History of Mining. Archeological discoveries

Mining is the process of extracting useful minerals from the surface of the Earth (including sea) usually from an ore body, vein or coal seam.

Archeological discoveries indicate that mining was known in prehistoric times. The first mineral found was flint, which could be broken to pieces that were useful as knives and arrowheads. Gold was one of the first metals utilized.

Gold was mined from streambeds of sand and gravel. Copper was probably the second metal discovered and used. Silver was also found and was valued more highly than gold. Other hard rock mined or collected for axes included greenstone.

The oldest known underground mine in the world was run more than 40,000 years ago in Swaziland to mine ochre used in burial ceremonies and as body colouring.

Georgius Agricola

The book on mining "De re Metallica" (1556) by the German scholar Georgius Agricola is the best source of information on early mining tech-

niques, many of which are still used or were used until recently: picks and hammers, ventilation and pumping systems and cart-like "tricks" for hauling minerals to name a few. Agricola describes detailed methods of drilling, shafts and tunnels, timber support systems, etc.

Great progress

Great progress in mining was made when the secret of black powder reached the West, probably from China in the late Middle Ages.

Gunpowder was replaced by dynamite in the mid-XIXth century. Since 1956 both ammonium nitrate and slurries (mixture of water, fuels and oxidizers) have come into use.

The invention of mechanical drills increased the capability to mine hard rock decreasing the cost and time for excavation by many times. The first rotary drill appeared in England in 1813. In Germany in 1853 a drill that resembled modern air drills invented. Pistol drills were followed by hammer drills run by compressed air.

Later advances included improvements in loading methods, usage of electric locomotives and conveyors, steam-driven pumps to remove water from the deep mines. In 1930s battery-powered cap lamps began entering mines...

Abridged from: Basic concepts of minerals mining technology. National Mining University/V. Bondarenko, I. Kovalevska, [etc]. – Dnipropetrovs'k: LizunoffPress, 2014. – 428 p. (in English)

Unit 4

PROSPECTING AND EXPLORATION

LEAD-IN

Match the English words with the pictures:

Several methods are used to find ore deposits. An important prerequisite for finding them is an understanding of the manner in which an ore deposit is formed. Several methods are used, in increasing order of cost per square kilometer:

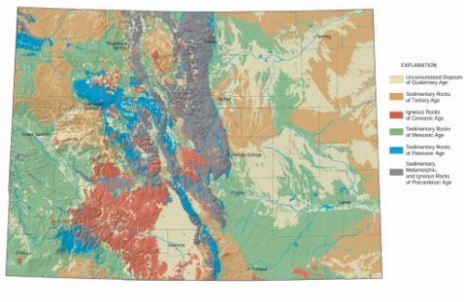
Low cost/km2

High cost/km2

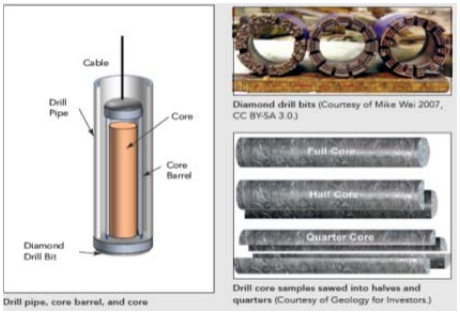
1. Remote sensing (satellite imagery)
2. Geological mapping
3. Geophysical survey
4. Geochemical surveys
5. Bulk sampling, drilling

a

b



c



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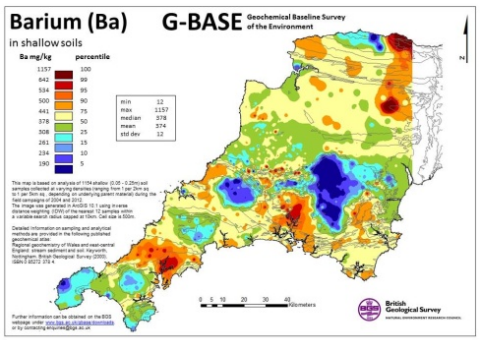

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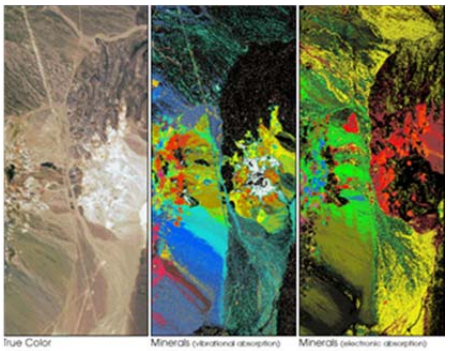


f

I. Read and remember the list of words associated with Prospecting.

1)	aerial	– воздушный; надземный
2)	certain certainly	– определенный; некоторый; конечно
3)	cost	– стоить; цена; стоимость
4)	country rock	– коренная (основная) порода
5)	crop	– (out) обнажать(ся), выходить на поверхность (о пласте, породе)
6)	distinctive properties	– отличительные свойства distinctive properties
7)	dredging	– выемка грунта; драгирование
8)	drill	– бурить, сверлить; бурение, сверление; бурильный молоток
9)	drilling	– бурение, сверление; core-drilling колонковое (керновое) бурение
10)	to drive	– проходить (горизонтальную выработку); приводить в движение; управлять (машиной); горизонтальная выработка; привод; передача
11)	evidence	– основание; признак(и); свидетельства
12)	to develop	– разрабатывать (*месторождение*); развивать (*добычу*); производить подготовительные работы
13)	development	– подготовительные работы; развитие добычи; развитие
14)	to expect	– ожидать; рассчитывать; думать; предлагать
15)	to explore	– разведывать месторождение полезного ископаемого с попутной добычей
16)	exploratory	– разведочный
17)	exploration	– детальная разведка; разведочные горные работы по месторождению
18)	galena	– галенит, свинцовый блеск
19)	to indicate	– указывать, показывать; служить признаком; означать
20)	lead	– свинец
21)	to look for	– искать
22)	malleable metal	– ковкий металл
23)	to open up	– вскрывать (месторождение); нарезать (новую лаву, забой)

24) opening – горная выработка; подготовительная выработка; вскрытие месторождения
25) panning – промывка (золотоносного песка в лотке)
26) processing – обработка
27) processing industry – обрабатывающая промышленность
28) to prove – разведывать (характер месторождения или залегания); доказывать; испытывать, пробовать
29) proved – разведанный, достоверный
30) proving – опробование, предварительная разведка
31) to search – исследовать; (for) искать (месторождение); поиск; syn prospecting
32) sign – знак, символ; признак, примета
33) to store – хранить, накапливать (о запасах)
34) to work – работать; вынимать, извлекать (уголь, руду); вырабатывать
35) working – разработка, горная выработка
36) workable – подходящий для работы, пригодный для разработки, рабочий (о пласте); рентабельный

II. Read the following words and remember their pronunciation.

[i] – mineral, different, difference, fissure, distinctive
[i:] – region, need, seam, piece, relief, galena
[ɔ] – quality, quantity, copper, rock, crop
[ɔ:] – call, ore, small, explore, forecast
[æ] – extract, sand, gravel, valuable, map, locality
[Λ] – country, such, enough, lustre, lustrous, occurrence
[ei] – stage, data, nature, grey, mainly, explain, available
[ou] – float, stone, gold, expose, opening

III. Pay attention to the stress in the following words.

ga'lena	'evidence	ex'tract
'property	in'dustrial	'aerial
ex'plore	'lustrous	o'ccurrence
ex'ploratory	'forecast	'opening
re'search	'valuable	ˌobser'vation

READING

IV. Read the text and write whether the following statements are true (T) or false (F).

Statement		True/False (T/F)	
1.	The search for economically useful mineral deposits is called *proving*.		
2.	Last century prospectors looked for visible evidence of mineral deposits.		
3.	The science of geology can explain the mode of occurrence of ore deposits.		
4.	As a rule prospecting includes four stages.		
5.	The study of general topographical relief and the type of ground makes it possible to expose this or that deposit.		
6.	As it is known, veins are found in metamorphic rocks.		

Prospecting

Mining activities include prospecting and exploration for a mineral deposit through finding, proving, developing, extracting and processing the ore. That is why it is possible to divide the mining activity into three major phases: 1) *before mining* which involves prospecting and exploration required to locate, characterize and prove a potential ore body; 2) *mining* which refers to actual coal or ore extraction. Extraction processes include underground or surface mining and dredging; 3) *after mining* which involves processing and preparing the raw ore for the end product.

As has already been said, before a mineral deposit can be worked, that is, before it can be extracted from the Earth for use by man, it must first be found. The search for economically useful mineral deposits is called *prospecting*. To establish the quality and quantity of a mineral deposit, the type of country rock, etc. means to prove it and this process is called *proving*. Prospecting and proving are only two different stages of mining geological exploration; the latter includes drilling and driving of openings.

Last century prospectors looked for visible evidence of mineralization on the surface of the Earth. To recognize valuable minerals it was necessary to know their various distinctive physical properties. For example, gold occurs in nature as a heavy malleable yellow metal. Galena, the most important mineral containing lead, is dark grey, heavy and lustrous. The first ores of iron to be mined were deposits of magnetite, a black heavy mineral capable of attracting a piece of iron.

As the deposits of mineral that cropped out at the surface were mined, the search for additional supplies of minerals took place. The science of geology was used to explain the occurrence of ore deposits.

The aim of geological prospecting is to provide information on a preliminary estimation of the deposit and the costs of the geological investigations to be made. It also indicates whether it is available to continue the exploration or not.

Prospecting work includes three stages: 1) finding signs of the mineral; 2) finding the deposit; 3) exploring the deposit.

General indications of the possibility of exposing this or that mineral in a locality can be obtained by studying its general topographical relief, the type of ground and its general natural conditions. Thus, in mountainous regions where fissures were formed during the process of mountain formation, ore minerals could be expected in the fissure fillings. In hilly regions, sedimentary deposits would be expected.

Certain deposits are found only in a particular type of ground. Coal seams, for example, are found in sedimentary formations mainly consisting of sandstones and shales. Veins, on the other hand, are found in crystalline (igneous) rocks, and the type of country rock usually determines the type of minerals.

At present, prospecting methods to be used are as follows:

1. Surface geological and mineralogical prospecting such as panning.
2. Geophysical, geochemical, geobotanical prospecting.
3. Aerial photography with geological interpretation of the data to be obtained is highly effective from aircraft or helicopter. Besides, successful development of space research has made it possible to explore the Earth's resources from space by satellites.

In modern prospecting the methods mentioned above are used together with the study of geological maps.

Abridged from: Barakova M.Ya., Zhuravleva R.I. English for mining engineers. Moscow, 2001.

V. Read the text about Exploration of Mineral Deposits and match the headings (1–5) with the paragraphs (A–E).

1. Methods of detailed exploration
2. The main stages of mineral deposits exploration
3. Preliminary exploration
4. Exploitation exploration
5. Detailed exploration

Exploration of Mineral Deposits

A. _____ Exploration is known to include a whole complex of investigations carried out for determining the industrial importance of a deposit. It is divided into three stages, namely preliminary exploration, detailed exploration and exploitation exploration.

B. _____ The aim of preliminary exploration is to establish the general size of a deposit and to obtain an approximate idea of its shape, dimensions and quality. At this stage the geological map of the deposit is cor-

rected and a detailed survey of its surface is completed. The information on the preliminary exploration is expected to give an all-round description of the deposit which will enable the cost of its detailed exploration to be estimated. The following points should be taken into consideration: 1) the shape and area of the deposit; 2) its depth and angles of dip and strike; 3) its thickness; 4) the properties of the surrounding rock and overburden; 5) the degree of uniformity of distribution of the mineral within the deposit and the country rock, etc. Preliminary explorations can make use of exploratory openings such as trenches, prospecting pits, adits, crosscuts and boreholes. They are planned according to a definite system, and some are driven to a great depth.

C. _____ The task of the detailed exploration is to obtain reliable information on the mineral reserves, their grades and distribution in the different sectors of the deposit. Detailed exploration data provide a much more exact estimate of the mineral reserves.

D. _____ Mine or exploitation exploration is known to begin as soon as mining operations start. It provides data for detailed estimates of the ore reserves of individual sections. It facilitates the planning of current production and calculating the balance of reserves and ore mined.

The searching and discovering of new mineralized areas are based on geological survey and regional geophysical prospecting. The results of these investigations provide data on iron-bearing formations and new deposits for commercial extraction.

E. _____ In detailed exploration both underground workings and borehole survey are used. Core drilling with diamond and carbide bits is widely used. Non-core drilling is also used in loose rocks in combination with borehole geophysical survey.

One of the main methods to explore coal deposits is also core-drilling. Modern drilling equipment makes it possible to accurately measure bed thickness and determine structure of beds, faults and folds. Recording control instruments are attached to drilling rigs which allow the geologists to get reliable samples good for nearly all parameters of coal quality to be determined.

Abridged from: Barakova M.Ya., Zhuravleva R.I. English for mining engineers. Moscow, 2001.

VOCABULARY AND TERMINOLOGY

VI. Read the texts above in detail and match the English word-combinations (1–10) with the Russian equivalents (a–k).

1) country rock	a) залегание рудных месторождений
2) panning	b) блестящий металл
3) the search for commercially useful deposits	c) коренная (основная) порода
4) geological exploration	d) дополнительные запасы минералов

5) to look for evidence of mineralization	e) промывка (золотоносного песка в лотке)
6) additional supplies of minerals	f) геологическая разведка (с попутной добычей)
7) distinctive properties	g) искать доказательства наличия месторождения
8) lustrous metal	h) поиски экономически полезных
9) capable of attracting a piece of iron	j) способный притягивать кусок металла
10) the occurrence of ore deposits	k) отличительные свойства

VII. Choose the correct variant a, b or c.

1. Mining activities include prospecting and exploration for a mineral deposit through _____.
   a. finding, proving, developing, extracting and processing the ore
   b. finding, proving, developing, extracting and processing oil
   c. finding, proving and extracting the ore
2. Prospecting work includes three stages _____.
   a. 1) finding the deposit; 2) exploring the deposit; 3) extracting the deposit.
   b. 1) finding signs of the mineral; 2) finding the deposit; 3) exploring the deposit.
   c. 1) finding the deposit; 2) extracting the deposit; 3) processing the deposit.
3. The aim of preliminary exploration is to establish the general size of a deposit and to obtain an approximate idea of its _____.
   a. shape, dimensions and quantity
   b. weight, dimensions and quality
   c. shape, dimensions and quality
4. Due to the current space research advancement it is possible to explore the Earth's resources from space by _____.
   a. airplanes
   b. satellites
   c. helicopters
5. Galena, the most important mineral containing lead, is _____.
   a. dark grey, light and lustrous
   b. dark grey, heavy and lustrous
   c. dark green, heavy and malleable
6. The search for _____ is called *prospecting.*
   a. only precious mineral deposits
   b. economically useful mineral deposits
   c. useful mineral deposits

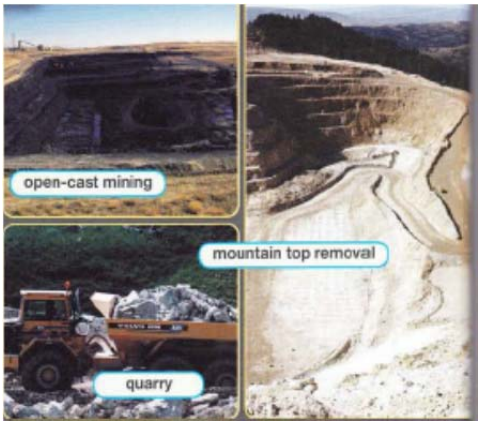
7. In detailed exploration _____.
   a. only underground workings are used
   b. both underground workings and borehole survey are used
   c. underwater workings are used
8. The searching and discovering of new mineralized areas are based on _____.
   a. geology
   b. geological survey and regional geophysical prospecting
   c. the general size of a deposit

VIII. Compose the sentences of the given words.

1. Called/useful/the/for/search/mineral/is/economically/deposits/prospecting.
2. In/gold/heavy/malleable/occurs/nature/a/metal/as/yellow.
3. Three/includes/stages/work/prospecting.
4. Core/is/drilling/with/widely/used/diamond.
5. Used/several/are/find/ore/deposits/methods/to.
6. Discovering/areas/based/of/new/mineralized/are/on/regional/survey/and/geophysical/prospecting/geological.

IX. Read the text about Surface mining. Complete the following sentences with one of the words in bold in the text given below.

1. _____ is mining by piping water down a vertical hole.
2. _____ is excavating a river or sea bed.
3. _____ is using high pressure water to remove deposits.
4. _____ is an open surface excavation for the extraction of materials.
5. _____ is drilling into the steep wall of a quarry.
6. _____ is using water to separate heavy minerals from lighter deposits.



The Preston Mining Company has a number of mines. Each site uses the best mining methods available. We operate an open-pit mine in central Mon-

tana. This open-cast mine produces copper. We also maintain several coal mines. Our miners use mountain top removal (MTR) and **highwall mining** methods. Our MTR sites are in Tennessee. In Colorado, we have several granite **quarries.** We also run three gold **placer mines** in the same region, primarily relying on **dredging** (in accordance with environmental regulations, we no longer use **hydraulicking).** Finally, we own a dozen salt mines. For these, we mostly extract the materials with **borehole mining** and leaching methods.

Abridged from: Virginia Evans, Jenny Dooley, Kenneth Rodgers. Career Paths: Natural Resources II — Mining (Student's Book). Express Publishing, 2014

X. Match the jobs in mining (a–k) with their definitions (1–10). Then read the sentences and rearrange the letters the letters to form the words and to complete the short descriptions of the activities of different mining professionals.

Mining jobs		Definitions
1) drill supervisor	a)	Someone who uses his or her expert knowledge of mechanical engineering principles to design new mining systems and equipment.
2) environmental engineer	b)	Someone who explores areas looking for minerals or other materials of value in the Earth and the person who determines whether or not a site should be more aggressively explored.
3) geochemist	c)	Someone who oversees the work of drilling operators, as well as works closely with management to develop operational plans.
4) geologist	d)	A person who extracts ore, coal, or other mineral from the earth through mining.
5) geophysicist	e)	Someone who uses the principles of engineering, soil science, biology, and chemistry to develop solutions to environmental problems.
6) hydrogeologist	f)	A scientist who uses both geology and chemistry to study the chemical make up of and interaction between various substances found in the earth.
7) miner	g)	A specialist whose duties focus on preventing accidents and lessening opportunities for human error in engineered environments or in engineering design.
8) mining engineer	h)	A scientist who researches groundwater systems. He or she conducts field studies to determine the location, size, and movement of underground water reservoirs.

9) prospector	j)	A scientist who studies the physical properties of the Earth, and who may also study the physical properties of other planets along with moons and other objects found in space.
10) safety engineer	k)	Someone who studies the Earth and the processes which shape it.

Abridged from: https://www.wisegeek.com/

There are two main activities in my job. Firstly to make holes in rock so that samples of the rock can be taken and to insert (a) (**leoivsxspe**) for blasting.

I make evaluations of conditions at a (b) **(ienm)** and check air pollution, waste disposal, and previously mined areas.

My job is to study the chemistry of (c) (**htare**) materials. I specialize in the study of the planet and the materials of which it is made. This information helps us to discover (d) (**nlriames)** and fuels.

I study and investigate phenomena which cause movement of the earth's surface. Through my studies I help others to locate petroleum and mineral (e) (**tseopids).**

I specialize in various branches of work, including (f) (**goespnrctip),** surveying, and technical underground management.

My job is to inspect all possible danger spots in the mine, prepare (g) (**sutdai)** and cooperate with committees to prevent unnecessary dangers.

Abridged from: Technical English Vocabulary and Grammar. Nick Brieger, Alison Pohl. Summertown Publishing. 2006. – 148 p.

GRAMMAR

Conditionals 3, Mixed

Type 3 Conditionals	They are used to express imaginary situations which are contrary to facts in the past. They are also used to express regrets or criticism.	**E.g.** John got up late, so he missed the bus. *If John hadn't got up late, he wouldn't have missed the bus.*
Mixed Conditionals	They refer to an unreal past condition and its probable result in the present. These sentences express a situation which is contrary to reality both in the past and in the present.	E.g. *If I had studied I would have my driving license.* (but I didn't study and now I don't have my license)

(For more details you may see Grammar Reference p. 170).

XI. Match Conditionals of 3/Mixed type (A–B) with the sentences (1–8).

Example: 1. If you had warned me then, I would not be in prison now. – Answer is B. (Mixed type)
A 3rd type
B Mixed type

1. You could have got a better job if you knew English.
2. The constructors would have built the road if they had had enough tools.
3. If I were you, I could have passed the exam.
4. The author would have finished the book if he hadn't been seriously ill.
5. He would have taken the job if he had found the offer acceptable.
6. If you had planned this properly, we wouldn't be in trouble now.
7. If I had accepted that job, I would be very rich.
8. The car engine would have worked if the mechanic had done his job properly.

XII. Open the brackets in the conditional sentences of type 3 and put the verbs in the correct form.

Example: *John __ (not have) a car accident if he __ (choose) another road. – John wouldn't have had a car accident if he had chosen another road.*

1. I __ (visit) Sarah yesterday if I __ (know) that she was ill.
2. If you __ (go) with me to Paris last month, you __ (see) the Eifel Tower too.
3. We __ (not get wet) if you __ (take) an umbrella.
4. If Mum __ (not open) the windows, our room __ (not be) full of mosquitoes.
5. Nick __ (not be) so tired this morning if he __ (go to bed) early last night.
6. If Felix __ (to be) here I __ (see) him.
7. If they __ (mention) this yesterday, everything __ (be done).

XII. Open the brackets to form conditionals. Mind mixed conditionals.

1. Michael would not agree even if you (to ask) _____ him.
2. If I (to find) _____ that letter, I'll show it to you.
3. If I meet him, I (to invite) _____ him.
4. Would they come if we (to invite) _____them?
5. The boss (be) _____ very disappointed if you aren't at the meeting tomorrow.
6. The old gentleman doesn't go out in winter. He _____ (go) out if the weather gets warmer.
7. If the plane had left on time, they _____ (be) in Minsk now.
8. If they hadn't walked 40 km, they _____ (not/be) exhausted now.
9. What would have become of us, if I _____ (come) to you then?
10. He would have been scrupulous – if he (can) _____.

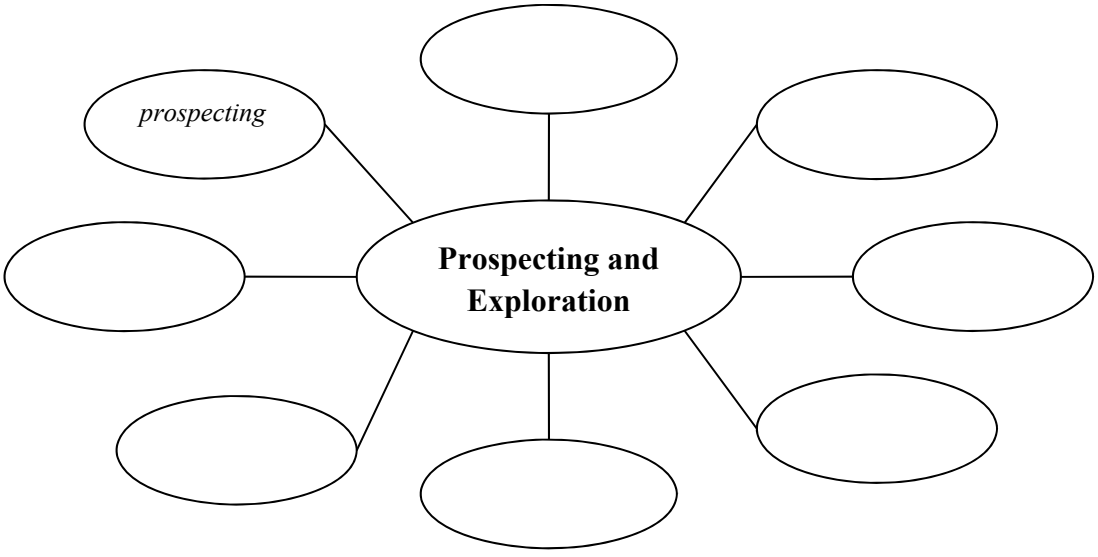
TRANSLATION

XIV. Translate the following conditional sentences with into Russian.

1. If conditions had permitted, the geologists would have applied aerial prospecting.
2. If the geological and prospecting indications are known, it is possible, even before prospecting proper begins, to forecast not only the type of economic deposit that may be found in the given conditions but also the associated elements and the whole complex of forecasting minerals.
3. Provided the geologists make use of proper prospecting methods, they will get necessary results.
4. On condition that different types of ores are to be tested separately each sample should represent a definite type of ore.
5. Unless the face is directly connected to the upper level, the combine does not cut the face for its whole length.
6. Mine workings are considered to be productive if they are driven with a view to extracting useful mineral.
7. I'd have been able to translate the letter if my English were better.
8. The cutter-loader will cut coal above the floor on condition that the thickness of overburden is small.

SPEAKING

XV. Fill in the spidergram with the words associated with Prospecting and Exploration and explain your associations.



Example: Prospecting work includes three stages: 1) finding signs of the mineral; 2) finding the deposit; 3) exploring the deposit.

XVI. Describe the pictures in 10 sentences.

Example: *In the first picture prospecting works are being done. Prospectors are studying…*

WRITING

XVII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176).

MINE EXPLORATION

Several methods are used to find ore deposits. An important prerequisite for finding them is an understanding of the manner in which an ore deposit is formed. Several methods are used, in increasing order of cost per square kilometer:

Low cost/km2 ↓ High cost/km2

1. Remote sensing (satellite imagery)
2. Geological mapping
3. Geophysical survey
4. Geochemical surveys
5. Bulk sampling, drilling

Geological Mapping

Once a favorable area has been identified, geologists go into the field and make a map of bedrock exposures, or outcrops, in the area to discern any spatial relationships that indicate the presence of economic deposits of minerals. Representative geological mapping requires ensuring that a rock exposure is bedrock, not a "bed boulder". (Usually the map is made with the aid of portable global positioning devices.) Indicators might be the actual mineral itself, but more likely it would be minerals that are associated with magmatic or hydrothermal activity that could have formed a high concentration of economic minerals. Structural controls on the location of mineralization, such as faults or folds, would also be located on a geologic map. The manner in which the minerals in the rock are affected by the forces that led to the formation of faults or folds may also be useful for determining details on the distribution of mineralization.

Geophysical Surveys

Geophysical surveys might be performed to find changes in physical properties in the area. Examples of physical properties might be the earth's magnetic field, the density of rocks, or the response of the rocks to a radio signal. The presence of metals in the rock would alter the earth's magnetic field intensity and would also change the response to a radio signal. The force of gravity over light rocks would be less than the force of gravity over surrounding denser rocks. All of these properties can be measured with sophisticated and sensitive instruments. The result is a map of changes in these properties, and it is the significant changes, called anomalies, that might indicate something of interest is present.

Geochemical Surveys

Groundwater in contact with an ore body will leach minerals and deposit them in overlying soil or streams. Trees may also take up the water. The closer an ore body is to the surface, the more likely there will be concentrations of metals in soils, water, and trees that can be detected by taking soil, stream sediment, or plant samples and analyzing them chemically. These concentrations, measured in parts per million and sometimes parts per billion, may form a geochemical anomaly – a location for further exploration.

Drilling

The purpose of drilling is to obtain physical core samples of the rock mass that can be analyzed for mineral or metal concentration. Core drilling is done by means of a core barrel, an approximately 3-m-long tube that is inserted into a drill pipe. At the end of the drill pipe is a diamond drill bit that grinds up the rock as the pipe is rotated and advanced down a hole, forming a cylindrical stub of rock that breaks off and enters the core barrel. A "catcher" on the end of the core barrel keeps the core in the barrel when the barrel is pulled up the pipe.

When the core barrel is full, it is pulled up the drill pipe, and the core is extruded and placed in special boxes. Another length of drill pipe is attached at the top, and the empty core barrel is re-inserted and the process continues.

A typical drilling campaign can result in hundreds of meters of drill core samples. Some of the samples are sawed into halves or quarters; one part remains in the field and another part is sent to an assaying lab for chemical analysis or detailed mineralogical analysis using a microscope or X-ray methods.

Geologists will look at each of the samples to determine whether there are any economic minerals of interest, or indicators such as minerals or mineral alterations that might occur in an ore-forming system when minerals of economic interest are precipitated. This investigation process is called core logging.

Abridged from: Dunbar W.S. How mining works. Society for Mining, Metallurgy & Exploration (SME), 2016.

SELF-STUDY

OIL FORMATION

LEAD-IN

Oil, natural gas and petroleum have been foremost on people's minds for the past years. Nations and the world are run by oil. It fuels our cars, our homes and provides us with electricity. It is used in the making of plastics and cosmetics. Oil is also prevalent in our lives but most people don't know where the oil we use comes from.

I. Read and remember the list of the words associated with oil formation.

1) abundance – распространённость
2) adjacent (to) – смежный, прилегающий
3) apex – вершина
4) compaction – уплотнение
5) cook (v) – подвергаться тепловой обработке
6) crude oil – сырая нефть
7) depression – впадина
8) decompose – decomposition – разлагаться – разложение
9) expansion – распространение (на большую площадь)
10) fold – складка
11) fracture – разлом, трещина
12) hydrocarbons – углеводороды
13) kerogen – кероген
14) lens – чечевицеобразная залежь, линза
15) mixture – смесь
16) mudstone – аргиллит
17) interweave (v) – перемешивать, вкраплять
18) separation – разделение, разложение на части
19) refining – очистка, перегонка (нефти)
20) volatile – летучий, быстро испаряющийся
21) viscous – густой, вязкий
22) recover oil – добывать нефть
23) residue – остаток
24) reservoir rock – порода – коллектор
25) source rock – материнская порода
26) permeable (impermeable) – проницаемый
27) permeability – проницаемость

28) pocket	– карман
29) porous	– пористый
30) porosity	– пористость
31) preserve (v)	– сохранять
32) cap rock	– покрывающая порода, покрышка залежи
33) sulfur	– сера
34) nitrogen	– азот
35) oxygen	– кислород
36) feedstock	– исходный сырое
37) split up (v)	– разделять
38) be arranged	– систематизированный
39) tarry	– смолистый
40) alter (v)	– изменить
41) sink (v)	– погружаться
42) decay	– сгнивший
43) fine-grained	– мелкозернистый
44) exert (v)	– оказывать давление
45) trap	– ловушка
46) property	– свойство
47) shale	– сланец
48) source rock	– материнская порода
49) accumulate (v)	– накапливать; накоплять
50) limestone	– известняк
51) sandstone	– песчаник
52) unconformity	– несогласное напластование

II. Pay attention to the pronunciation of the following terms.

[aɪ] nitrogen, hydrocarbon, refining
[e] residue, buried, dead, lenses, ethane
[eɪ] chain, available, able, locate, basin
[ə:] permeable, exert, refer, occur, preserve
[i:] methane, heat
[o:] source, porous, fault, salt, alter
[tʃ] mixture, structure, manufacture, saturated
[ʃ] pressure, partially, depression, sufficiently, ocean
[k] chemical, unique

III. Pay attention to the stress in the following words.

u´nique	ˌhydro´carbon	´residue
´chemical	´methane	ˌmanu´facture

READING

IV. Read the text and write whether the following statements are true (T) or false (F).

Statement	True/False (T/F)	
1. Most people think that crude oil is a liquid mixture of naturally occurring carbohydrates.		
2. Hydrocarbons are complex molecules that are formed from long strings of hydrogen and carbon such as propane (C_3H_8) or butane (C_4H_{10}).		
3. Something needs to block or trap the petroleum so it will accumulate into a large enough deposit for geologists to be able to locate it.		
4. Anticlines bend the reservoir rock and create a pocket at the apex of the fold where the petroleum can migrate.		
5. Structural traps work by folding or breaking the reservoir rock and placing it adjacent to an impermeable rock layer.		
6. Salt domes can push up through buried sediment and deform the overlying layers of rock.		

HOW OIL BECOMES OIL

Petroleum (literally rock oil, from the Greek *petra-* for rock and Latin - *oleum* for oil) is a general term used to refer to all forms of oil and natural gas that is mined from the earth. What most people concern themselves with is crude oil, the liquid mixture of naturally occurring hydrocarbons, and natural gas, which is a gaseous mixture of naturally occurring hydrocarbons. Hydrocarbons are complex molecules that are formed from long strings of hydrogen and carbon, such as propane (C_3H_8) or butane (C_4H_{10}).

Petroleum is the final product that we get out of the ground. But how does it get there? Petroleum begins as living animals, microscopic organisms (like diatoms or plankton) that live in the oceans. When these organisms die, their bodies sink and collect on the ocean floor. These organisms live all over the oceans and their bodies fall and collect on the ocean bottoms all over the world. When the organic matter becomes buried and begin to decompose, they are referred to as **kerogen.** Despite the apparent **abundance** of dead organisms raining down on the ocean bottoms, there are specific conditions that must be met for these organisms to be transformed into petroleum.

First, the area that the kerogen collects must be a restricted basin, a depression where sediment can accumulate and where there is poor water circulation. When the oxygen is gone, the **decomposition** stops and the remaining

matter are **preserved**. The kerogen must be buried under sediment where it will be altered through high temperatures and high pressures. As the heat and pressure breaks down the kerogen, the hydrocarbon chains are freed. Long chains of hydrocarbon are oil; shorter chains are gas, generally methane (CH_4) and condensates such as ethane, propane and butane. As the heat and pressure continues, the longer chains will continue to break into shorter chains. If the process continues long enough, all that will remain will be methane.

Compaction of the sediment, and the **expansion** of the kerogen as it is transformed into petroleum cause it to be forced out of the rock it was created in (the source rock) and into nearby sediments. If these sediments are porous enough (have microscopic holes) and permeable enough (allowing for the flow of liquids), then the petroleum will migrate through the rock. Since gas and oil are lighter than water, they can travel through water-saturated rock. Eventually the oil will stop migrating as it meets rock that is not porous or permeable, and will collect in a trap. It is these petroleum traps that geologists search for and that the oil companies drill into **to recover the oil**.

Despite the simplicity, there are several conditions that must occur, otherwise, no oil will be made. First, there needs to be a source rock that contains the organic matter to be converted into petroleum. This source rock is generally shale or other **mudstones**. There must be a reservoir rock, usually sandstone or limestone that is porous and permeable where the oil can be stored and transported. There needs to be a trap, something that is non-porous and non-permeable that will hold the petroleum in the reservoir and prevent it from migrating further. Finally, there needs to be enough heat and pressure to sufficiently **cook** the oil and gas **out of** the kerogen. If anyone of these conditions is not met, then petroleum cannot be formed.

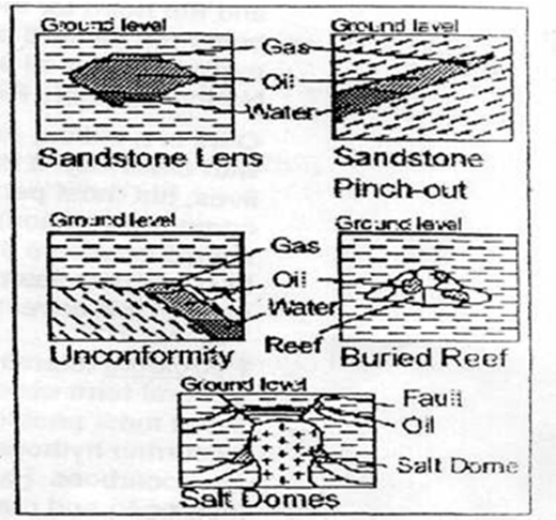
The important step in the process is the trap. Something needs to block or trap the petroleum so it will accumulate into a large enough deposit for geologists to be able to locate it. Petroleum traps come in several varieties, in various sizes and can be made through structural processes (like folds and faults), or by sedimentary processes.

Structural traps work by folding or breaking the reservoir rock and placing it **adjacent** to an impermeable rock layer, like shale. There are three types of structural traps. One of the most common is a trap from the folding of the rocks. Anticlines bend the reservoir rock and create **a pocket** at the **apex** of the **fold** where the petroleum cannot **migrate.** Normal and **thrust faults** can result in petroleum traps by breaking the reservoir rock and moving it so that it is against an impermeable rock layer.

The other way to trap petroleum is through stratigraphic traps. The diagram shows five different types of stratigraphic traps. The differences between these and structural traps is that these traps occur by the nature of how the sediment was deposited and not whether it was broken or folded. The first

two, sandstone **lenses** and sandstone pinch-outs, are the result of the changes in deposition of the sediment. Thick layers of mud are covered by thinner layers of sand from migrating shoreline, or by the sand deposited by large rivers. As sea level changes or rivers migrate, the different sand and mud layers are **interwoven** creating lenses or **pinch-outs**. These sand layers allow the petroleum to accumulate and the mudrock layers trap the petroleum.

Unconformities can create traps by burying **truncated** sandstone or limestone layers with layers of mudstone.



Finally, salt domes can push up through buried sediment and deform the overlying layers of rock. This causes folds and **fractures** to form in the rock, trapping the oil salt domes are the primary places where the oil is found.

Abridged from: Petroleum Engineering: Course book, TPUPublishing House, 2010.

/Author: Geoff Habiqer Published on: September 3, 2001.

V. Read the text about oil formation and match the headings 1–6 with the paragraphs A–F.

1. Arrangement of hydrocarbon molecules ____
2. What is crude oil? ____
3. Different mixtures of hydrocarbons ____
4. Modification of hydrocarbon molecules ____
5. Oil formation ____
6. Oil and gas products ____

A. Crude oil is a complex **mixture of hydrocarbons** with minor proportions of other **chemicals** such as compounds of **sulphur, nitrogen and oxygen**. To use the different parts of the mixture they must be separated from each other. This **separation** is called **refining.**

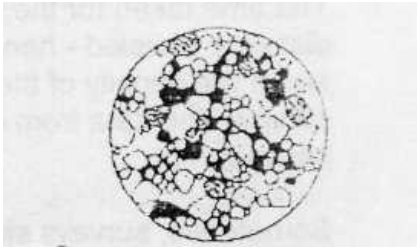
B. Crude oils from different parts of the world, or even from different **depths** in the same oilfield, contain different mixtures of hydrocarbons and other compounds. This is why they vary from light colored **volatile liquids** to thick, dark oils – so **viscous** that they are difficult to pump from the ground.

C. Hydrocarbons vary in structure depending on the number of carbon atoms and the way in which the hydrogen atoms combine with them. Hydrocarbons **can be arranged** as straight chains, branched chains or closed rings. There are two main chemical families of hydrocarbons – the alkanes and the alkenes.

D. As the structure of hydrocarbons varies so much, thousands of synthetic products can be manufactured with many different **properties**. Hydrocarbons with small molecules make good fuels. Methane (CH_4) has the smallest molecules, and is a gas, used for cooking and heating and generating electricity. Gasoline, diesel, aviation fuel and fuel oil are all liquid fuels.

E. Hydrocarbon molecules can **be split up** into smaller ones, or built up into bigger ones, or **altered** in shape, or **modified** by adding other atoms. This is why they are a very useful starting point (called a chemical **feedstock**) for making other materials. Even the thick black **tarry residue** left after distillation is useful. It is called bitumen, and is used in tarmac for road surfacing, and for roofing.

F. Oil is formed from the remains of tiny plants and animals (plankton) that died in ancient seas between 10 and 600 million years ago. After the organism died, they **sank** into the sand and mud at the bottom of the sea. Over the years, the organisms **decayed** in the sedimentary layers. In these layers there was little or no oxygen present. So microorganisms broke the remains into carbon-rich compounds that formed organic layers. The organic material mixed with the sediments, forming **fine-grained shale**, or **source rock.** As new sedimentary layers were deposited, they **exerted** intense pressure and heat on the source rock. The heat and pressure distilled the organic material into crude oil and natural gas. The oil flowed from the source rock and **accumulated** in thicker, more **porous limestone** or **sandstone**, called **reservoir rock**. Movements in the Earth **trapped** the oil and natural gas in the reservoir rocks between layers of **impermeable rock**, or **cap rock**, such as granite or marble.



Close-up of reservoir rock (oil is in black)

Abridged from: Petroleum Engineering: Course book, TPUPublishing House, 2010

VOCABULARY AND TERMINOLOGY

VI. Read the text OIL FORMATION in detail and match the words in column A with the words in column B to form word-combinations. Then give Russian equivalents to these word-groups.

Example: *(1b)* complex mixture of hydrocarbons – *сложная смесь углеводородов*

A		B	
1)	complex mixture of	a)	into
2)	distilled	b)	~~hydrocarbons~~
3)	different depths	c)	left after
4)	from light	d)	pressure and heat
5)	depending	e)	properties
6)	many different	f)	coloured to thick
7)	be altered	g)	on the number
8)	tarry residue left after	h)	material mixed with
9)	organic	i)	in the same oilfield
10)	intense	j)	in shape

VII. For questions 1–6, choose one of the words (a–f) that best completes the gap in the text.

a)	**hydrogen**	**c)**	**transportation**	**e)**	**processes**
b)	**contain**	**d)**	**chains**	**f)**	**molecules**

Crude oil and natural gas are often found together. They are both made of hydrocarbons, which are (1) _____ that contain only carbon and (2) _____ atoms. Hydrocarbons (3) _____ a lot of energy. When we burn them, we get this energy. We use hydrocarbons for fuel for heating, cooking, and (4) _____. Besides, we use chemical (5) _____ to change the hydrocarbon (6) _____ to make nylon, medicines, and lots of different products.
Abridged from: Jon Naunton, Alison Pohl. Oxford English for careers. Oil and gas 2. Oxford University Press, 2011.

VIII. Fill in the gaps with the derivatives.

porous porosity decompose decomposition permeable permeability

1. A mixture of hydrogen is obtained from the _____ of water with carbon and phosphorous.
2. If a substance is _____, it allows liquids or gases to go through it.
3. _____ is the ratio of pore volume to its total volume.
4. Microbes _____ organic waste into a mixture of methane and carbon dioxide.
5. Something that is _____ has many small holes, so liquid or air can pass through, especially slowly.
6. Chalk has a high _____ (= liquids easily pass through it).

IX. Complete the sentences using the information from the texts given above.

1. Crude oil is a mixture of _____.
2. Hydrocarbon structure depends on _____.
3. Two main chemical families of hydrocarbons _____.
4. Hydrocarbon molecules are chemical feedstock for _____.
5. Thick black tarry residue left after distillation is _____.
6. Bitumen is used in _____.
7. The organic material mixed with the sediments, forming _____.

X. Answer the questions.

1. What product do we get out of the ground?
2. What collects on the ocean bottoms all over the world?
3. Is there an abundance of dead organisms?
4. What is needed for organisms to be transformed into petroleum?
5. What conditions are needed for the oil to be made?
6. How do structural traps work?
7. What are structural traps?
8. What is the difference between structural and stratigraphic traps?
9. Can you name some of the stratigraphic traps?
10. What are salt domes for?

GRAMMAR

XI. Choose the correct answer a, b or c.

1. If I knew his address, I ___ him.
   a) visited
   b) would visit
   c) had visited
2. If Tom ___ the bus, he would have come to the meeting on time.
   a) hasn't missed
   b) missed
   c) hadn't missed
3. If I see Jill, I ___ her to call you.
   a) would remind
   b) will remind
   c) has reminded
4. We will stay at this hotel provided it ___ much.
   a) doesn't cost
   b) didn't cost
   c) hadn't cost
5. If Mark ___ for the job, he would have got it.
   a) applies
   b) will apply
   c) had applied

6. If he had phoned me, I ___ him the home task.
   a) would have told
   b) would tell
   c) told
7. They'll go to the restaurant if they ___ a table in advance.
   a) would reserve
   b) reserve
   c) reserved
8. If Mark ___ so much, he would be fit.
   a) didn't ate
   b) won't eat
   c) didn't eat
9. We'll miss you a lot in case you ___ to another house.
   a) will move
   b) would move
   c) move
10. I won't believe you unless you ___ clear evidence.
    a) give
    b) will give
    c) had given
11. We would have been injured in the crash if we ___ seatbelts.
    a) hasn't been wearing
    b) hadn't been wearing
    c) wore
12. If John ___ the local race, he will take part in the national championship.
    a) won
    b) wins
    c) would win
13. I ___ in case I am not right.
    a) has apologized
    b) would apologize
    c) will apologize
14. If I were you, I ___ about the incident.
    a) wouldn't have worry
    b) hadn't have worried
    c) wouldn't worry
15. If Jack hadn't passed all the exams, he ___ the university.
    a) wouldn't have finished
    b) didn't finish
    c) hadn't finished

TRANSLATION

XII. Read the text, write out the conditional sentences and translate them into Russian.

The exploration of an exotic planet

Let us see what it means to explore a planet like the Earth. Imagine us living on some other planet, say, Mars. Let us start with ground-based observations. If we looked at the Earth from Mars using a large telescope, it would appear as a cloud-covered and distant planet. The bright features would soon be recognized as clouds. The underlying dark features would represent the earth's surface. If we studied the surface features for a long time, their accurate map could be constructed. If spectroscopic investigation of the Earth's atmosphere in the ultraviolet, visible and infrared regions of the spectrum were carried out, it would give approximately correct information about such gases as oxygen, carbon dioxide, nitrogen and ozone. Investigations of the infrared spectrum of atmosphere gases would indicate the variation of temperature and pressure with altitude.

These conclusions could be checked if we sent a spacecraft to orbit the Earth. But if we had wanted to study the planet more thoroughly, we should have sent a land mission to the Earth.

Abridged from: English. Coursebook for postgraduates TPUPublishing House A.A. Demina, I.A. Matveenko, A.N. Oleynik. 2011.

WRITING

XIII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176).

What are hydrocarbons?

Hydrocarbons are organic chemical compounds that consist entirely of carbon and hydrogen, and range from simple molecules such as methane, to polymers such as polystyrene, which consists of thousands of atoms. The ability of carbon atoms to bond strongly to each other allows them to form an almost unlimited variety of chains, rings, and other structures that form the backbones of organic molecules. Since each atom can form four bonds, these backbones include other elements, such as hydrogen. The compounds are flammable, since the two elements they contain will combine easily with oxygen in the air, releasing energy. Fossil fuels, such as oil and natural gas, are naturally occurring mixtures of hydrocarbons; coal also contains some, although it is mostly just carbon.

Structure and Naming Conventions

The naming of hydrocarbons follows certain conventions, although in many cases, compounds may be better known under older names. In the modern system, the first part of the name represents the number of carbon at-

oms in the molecule: in ascending sequence, the first eight are prefixed*meth-, eth-, prop-, but-, pent-, hex-, hept- and oct-*. Compounds where the carbons are all joined by single bonds are known collectively as *alkanes*, and have names ending in –ane. Therefore, the first eight alkanes are methane, ethane, propane, butane, pentane, hexane, heptane and octane.

Carbon atoms can also form double or triple bonds with one another. Molecules that have double bonds are known as alkenes, and have names ending in *–ene*, while those that have triple bonds are called alkynes, and have names ending in *-yne*. Molecules that have only single bonds contain the maximum possible number of hydrogen atoms, and are therefore described as saturated. Where there are double or triple bonds, there are fewer places available for hydrogen, so these compounds are described as unsaturated.

To give a simple example, ethane has two carbons joined by a single bond, leaving each able to bond to three hydrogen atoms, so its chemical formula is C_2H_6 and it is an alkane. In ethene there is a carbon-carbon double bond, so it can only have four hydrogens, making it an alkene with the formula C_2H_4. Ethyne has a triple bond, giving it the formula C_2H_2, and making it an alkyne. This compound is better known as acetylene.

The carbon atoms can also form rings. Alkanes with rings have names beginning with*cyclo-*. Therefore, cyclohexane is an alkane with six carbon atoms joined by single bonds in such a way as to form a ring. A ring with alternating single and double bonds is also possible, and is known as a benzene ring. Hydrocarbons containing a benzene ring are known as aromatic, because many of them are pleasant-smelling.

Some hydrocarbon molecules have chains that branch. Butane, which normally consists of a single chain, can exist in a form where one carbon atom is bonded to two others, forming a branch. These alternative forms of a molecule are known as isomers. The branched isomer of butane is known as isobutane.

Abridged from: https://www.wisegeek.com/what-are-hydrocarbons.htm

Key to SELF-STUDY

IV. 1T 2T 3T 4F 5T 6T

V. 1C 2A 3B 4E 5F 6D

VI. Suggested answers

Example: *(1b)* complex mixture of hydrocarbons – *сложная смесь углеводородов*

1. **b** complex mixture of hydrocarbons – *сложная смесь углеводородов.*
2. **a** distilled into – *дистилированный в/преобразованный в.*
3. **i** different depths in the same oilfield- *разные глубины в одном и том же месторождении.*
4. **f** from light-coloured to thick – *от слабоокрашенного до насыщенно окрашенного.*
5. **g** depending on the number – *в зависимости от количества.*
6. **e** many different properties – *множество различных свойств.*
7. **j** be altered in shape – быть *измененным по форме.*
8. **c** tarry residue left after – *смолистый осадок оставшийся после.*
9. **h** organic material mixed with – *органическое вещество смешанное с.*
10. **d** intense pressure and heat – *мощное давление и высокая температура.*

VII. 1f 2a 3b 4c 5e 6d.

VIII. 1. decomposition 2. permeable 3. Porosity 4. decompose 5. porous 6. permeability.

IX.

1. hydrocarbons and other compounds
2. the number of carbon atoms
3. the alkanes and the alkenes
4. for making other materials
5. useful
6. tarmac for road surfacing, and for roofing
7. fine-grained shale, or source rock

GRAMMAR

XI. 1. B; 2. C; 3. B; 4. A; 5. C; 6. A; 7. B; 8. C; 9. C; 10. A; 11. B; 12. B; 13. C; 14. C; 15. A.

TRANSLATION

XII. Suggested answers:

1. Если бы мы посмотрели на Землю с Марса через большой телескоп, она бы выглядела как далекая и покрытая облаками планета.

2. Если бы мы изучали особенности поверхности в течение длительного времени, можно было бы создать их точную карту.
3. Если бы проводилось спектроскопическое исследование атмосферы Земли в ультрафиолетовой, видимой и инфракрасной областях спектра, оно давало бы приблизительно точную информацию о таких газах, как кислород, углекислый газ, азот и озон.
4. Данные выводы можно было бы проверить, если бы мы отправили космический корабль на орбиту Земли.
5. Но если бы мы хотели более тщательно изучить планету, нам следовало бы послать космическую экспедицию на Землю.

TEST 2

Variant 1

READING

I. Read the text and match the headings (1–4) with the paragraphs (A–D).

1. The most malleable of all the metals ____
2. An essential component for photographic film ____
3. Finding of a new metal ____
4. The discovery caused human deaths ____

PRECIOUS METALS

A. When Christopher Columbus discovered the Americans in 1492, Spanish expeditions soon followed, and though they are much criticised for their cruelty, greed and treachery, the military achievements of the 'Conquistadors' were remarkable. First they conquered Mexico and took away its valuable treasures. Seeking more land and wealth they invaded Peru, home of the Incas. Here they murdered the king and stole his vast hoard of gold – probably the greatest in the world. The natives were enslaved and set to work to win more gold. Later the Spanish conquered Chile and Bolivia, both of these countries being rich in precious metals, particularly silver.

B. To the metallurgists, the most exciting discovery made by the Spaniards was the finding of platinum in the silver mines of Mexico. At that time the new metal was regarded as more of a nuisance than of value. It could not be melted by any known method, though it was possible to make a very realistic imitation of gold from it. Later it joined the group of precious metals and is now used for jewelry and in industry.

C. Gold is the most malleable of all the metals. It can be hammered into sheets so thin that 250 of them would equal the thickness of a sheet of paper. It is also the most ductile metal. One gram of gold can be drawn into a wire 1.8 miles in length. Gold is the least chemically active of all metals and does not combine with oxygen to form rust. This ability to resist corrosion makes it very durable, i. e. it may last for centuries. Pure gold is too soft to be used in jewelry so it is usually alloyed with other metals. The proportion of gold in an alloy is measured in karats. Pure gold is 24 karats. A 14 karat gold ring is an alloy of about 58 % of gold and small percentages of copper and silver.

D. Silver is similar to gold in many ways. Like gold, it is very malleable and ductile and so it is also used for jewelry. Silver differs from gold in that it is more reactive and tarnished when exposed to the traces of sulfur in the air. Pure silver is too soft and so it is usually alloyed with copper to increase its hardness and durability. Silver is used for coins and for photographic film

because certain compounds of silver, such as silver bromide, reflect light. Silver is the best conductor of electricity known.

Abridged from: English. Correspondence Course. Student's book, TPUPublishing House, 2014.

II. Read the text about mining. Write whether the following statements are true (T) or false (F).

Statement	True/False (T/F)	
1. The term "mining" includes the recovery of oil and gas from wells; coal, iron ores and other useful minerals from the earth.		
2. There are only two mining methods.		
3. The problem of depth also affects the mining method.		
4. If the rock containing the metallic substance is at a deep site, it is massive.		
5. Mine workings vary only in shape.		
6. Depending on their function mine workings are described as exploratory or productive.		

MINING

Mining refers to ore extraction. Mining is the industrial process of removing a mineral-bearing substance from the place of its natural occurrence in the Earth's crust. The term "mining" includes the recovery of oil and gas from wells; metal, non-metallic minerals, coal, peat, oil shale and other hydrocarbons from the earth.

Mining can be done either as a surface operation (quarries, opencasts or open pits) or by an underground method. The mode of occurrence of the sought-for metallic substance governs to a large degree the type of mining that is practiced. The problem of depth also affects the mining method. If the rock containing the metallic substance is at a shallow site and is massive, it may be economically excavated by a pit or quarry-like opening on the surface. If the metal-bearing mass is tabular, as a bed or vein, and goes to a great distance beneath the surface, then it will be worked by some method of underground mining. Working or exploiting the deposit means the extraction of mineral. Mine workings vary in shape, dimensions, location and function.

Depending on their function, mine workings are described as exploratory to find or prove mineral, and productive when used for the immediate extraction of useful mineral. Productive mining can be divided into capital investment work, development work, and face or production work. Investment work

aims at ensuring access to the deposit from the surface. Development work prepares for the face work, and mineral is extracted (or produced) in bulk.

Abriged from: Abridged from: Barakova M.Ya., Zhuravleva R.I. English for mining engineers. Moscow, 2001.

III. Read the text below and answer the questions.

1. What are two major hypotheses for the origin of gold within the Witwatersrand basin?
2. What century do these hypotheses date back to?
3. What is the palaeoplacer theory?
4. What is the synsedimentary theory?
5. What are the key arguments in favor of a placer origin?
6. Why are the principal arguments for a hydrothermal origin?

Witwatersrand Conglomerate Gold Genesis Theories

There are two major hypotheses for the origin of gold within the Witwatersrand basin – the "placer" model and the "hydrothermal" model. Both concepts date back more than 100 years. Determining which of these theories is correct not only concerns earth scientists, but it also has great economic significance for mining companies. The exploratory strategies for gold within the Witwatersrand basin and other parts of the world are continually being modified according to current scientific models.

Theories of Genesis

They are: (1) *palaeoplacer theory* – developed either by normal placer-forming mechanisms, or by precipitation of gold in suitable environments; (2) *synsedimentary theory* – conglomerates were merely the porous sediments within which gold and sulfides were deposited from hydrothermal solutions derived either from a magmatic source or from dehydration of the West Rand Group shales.

(1) The key arguments in favor of a placer origin are the strong spatial correlation between gold, uraninite, and detrital zircon, and the intimate relationship between the heavy minerals and the sedimentary structures and environment. Another point is the equal intensity of mineralisation in porous conglomerates and less porous pyritic quartzites. The main drawback is a mineralogical one: the very small particle size of the gold, its hackly shape, and low fineness (i. e. high % Ag) (more typical of hydrothermal deposits) the presence of pyrite, uraninite, and the absence of black sands typical of modern placers. Another major problem is the source of the large quantity of gold and uranium in the basin, far more than is likely to have been derived from any Archaean greenstone belt, certainly more than from the most productive South African greenstone belt, Barberton. While it is certain that greenstone

belts were part of the source area, it seems likely that the gold and uranium could also have been derived from altered granites.

(2) The principal arguments for a hydrothermal origin are that the gold is crystalline, sometimes replaces pebbles, may be contained within and replace pyrite that has replaced pebbles, and is associated with a suite of hydrothermal ore minerals and alteration products (sericite and chlorite) typical of hydrothermal orebodies the world over. Nowadays, the modified placer theory emphasizes the control on the occurrence of ore minerals by placer-forming mechanisms, as well as, some modification by metamorphism.

Abridged from: Introduction into Mineral Exploration – edited by Charles J. Moon, Micheal K.G. Whateley and Anthony M. Evans; Blackwell Publishing – 2006.

VOCABULARY AND TERMINOLOGY

IV. Read the text Witwatersrand Conglomerate Gold Genesis Theories in detail and match the English word-combinations (1–10) with the Russian equivalents (a-j).

1)	greenstone belt	a)	продукт изменения, разрушения или разложения
2)	magnetic response	b)	механизмы нормального формирования прииска
3)	hydrothermal solutions	c)	золотой прииск, россыпь
4)	be restricted (v)	d)	осадочные комплексы, последовательности осадконакопления
5)	normal placer-forming mechanisms	e)	быть ограниченным
6)	placer deposits	f)	магнитная восприимчивость
7)	pyritic quartzite	g)	диоритовый пояс
8)	sedimentary sequence	h)	структурные остатки
9)	structural remnants	i)	гидротермальные растворы
10)	alteration product	j)	пиритовый кварцит

V. For questions 1–6, choose one of the words (a–f) that best completes a gap in the text.

a)	**lead**	**c)**	**ferrous**	**e)**	**radioactive**
b)	**base**	**d)**	**handle**	**f)**	**valuable**

Types of Metals

Mining for metals is a major part of the mining industry. There are four types of metals. **(1)**_____ metals are one type. These metals contain iron. For example, stainless steel is a ferrous metal. **(2)**_____ metals are a second type of metal. **(3)**_____ and copper are base metals. Unlike base metals, precious

metals are not very common. Precious metals are typically very **(4)_____**. Silver, gold and platinum are precious metals. The final type of metal is **(5)_____** metals. Radioactive metals can be dangerous. For this reason, miners should **(6)_____** radioactive metals like uranium carefully.

Abridged from: Virginia Evans, Jenny Dooley, Kenneth Rodgers. Career Paths: Natural Resources II — Mining (Student's Book). Express Publishing, 2014

VI. Fill in the gaps with the given derivatives.

fossilized fossils fossilize fossilization fossiliferous

1. Heavy mining equipment and dynamite was used to blast away overlying strata to uncover the _____ rock layers in the cliff face.
2. Jellyfish have such soft bodies, it's rare that they become _____.
3. Skin and soft tissues rot down quickly before _____ takes place.
4. The book is far more than a mere description of sedimentary indicators of facies and of _____ as tracers of environment.
5. He collected plant specimens both living and _____.
6. Nevertheless, the fossil record of cephalopod eggs is scant since their soft, gelatinous eggs decompose quickly and have little chance to _____.

VII. Complete the summary of the text Witwatersrand Conglomerate Gold Genesis Theories. Use only one word in each sentence.

1. There are two major _____ for the origin of gold within the Witwatersrand basin.
2. Due to current scientific models, the exploratory strategies are continually being _____.
3. The palaeoplacer theory *i*s developed either by normal _____ mechanisms, or by precipitation of gold in suitable environments.
4. The synsedimentary theory claims that _____ were merely the porous sediments within which gold and sulfides were deposited.
5. One of the points in favor of this theory is the equal intensity of _____ in porous conglomerates.
6. The main drawbacks are the very small particle size of the gold, its hackly shape, and low fineness, the presence of pyrite, uraninite, and the _____of black sands.
7. Another problem is the _____ of the large quantity of gold and uranium in the basin.
8. One of the arguments for a hydrothermal origin is that the gold is associated with a suite of hydrothermal ore minerals and _____ products.

VIII. Match the term (1–10) with the definition (a–j).

1)	dimension	a)	the existence or presence of something
2)	precipitation	b)	a group of minerals, rocks, or fossils occurring together and characteristic of a location or period.
3)	occurrence	c)	water that falls from the clouds towards the ground, especially as rain or snow
4)	placer	d)	a measurement of something in a particular direction, especially its height, length, or width
5)	fluvial	e)	a facies typified by the minerals characteristic of greenschists, thought to result from metamorphism at moderate temperature and pressure
6)	fossilization	f)	a deposit of sand or gravel in the bed of a river or lake, containing particles of valuable minerals
7)	greenschist facies	g)	a place, typically a large, deep pit, from which stone or other materials are or have been extracted
8)	alluvial	h)	the process of becoming a fossil (= something preserved in rock for a very long period)
9)	suite	i)	relating to or derived from alluvium.
10)	quarry	j)	of or found in a river.

GRAMMAR

IX. Use the verbs in brackets in the required form.

1. If we (to be able) to see the molecules in a bottle of oxygen gas, we should be surprised by the chaos and confusion.
2. Provided a piece of radium (to be brought) near a charged electroscope, the leaves will come together, thus showing the loss of charge.
3. If we not (to raise) temperature, the pressure would not increase.
4. If we had time enough, we (to repeat) our experiment.
5. If we (to solve) the problem of controlled thermonuclear reactions, we could use oceans of fuels.

X. Rewrite each conditional sentence of type 1 to form conditionals of type 2 and 3.

Example: *If I am not too busy, I shall go to the concert.* (type I)
If I were not too busy, I should go to the concert. (type II)
If I had not been too busy, I should have gone go to the concert. (type III)

1. They will all be surprised if I make such a mistake.
2. If he doesn't come in time, shall we have to wait for him?
3. If no one comes to help, we shall be obliged to do the work ourselves.
4. If you put on your glasses, you will see better.

5. What shall we do if they are late?
6. Will he be very displeased if I don't ring him up?

TRANSLATION

XI. Translate the following conditional sentences into Russian.

1. If the sun got its energy from ordinary chemical processes, such as the burning of coal and oil, it wouldn't last for more than several thousand years.
2. If one were to examine the stars on a clear, moonless night, he would soon discover that not all the visible stars are of the same degree and brightness.
3. If you look at the horizon immediately after sunset, you will often see a very bright star, Venus.
4. If it were possible to live on the moon, people would be able to jump about six times as high as they could on the earth.
5. The volume of gas will be proportional to its absolute temperature provided its pressure remains constant.
6. If there were no atmosphere, the surface of the earth would become very, very hot by day and too cold at night.
7. If the contact opens and closes very quickly, the amount of arcing will be greatly reduced.
8. Travellers will probably have to take a reserve of oxygen with them, if they fly to Venus.

WRITING

XII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176)

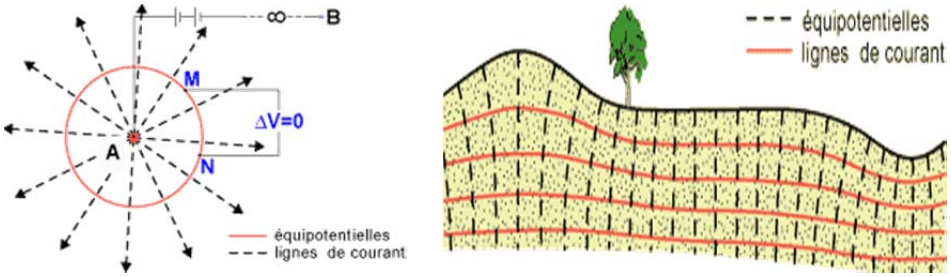
Electrical Methods

Mineral deposits and geologic structures may be mapped by their reaction to electrical and electromagnetic fields. These are produced by either direct or alternating current, except where ore bodies spontaneously furnish their own electrical field (self-potential methods). Electrical energy may be supplied to the ground by contact or by induction. Three main groups of electrical methods may be distinguished: (1) self-potential, (2) surface-potential, and (3) electromagnetic methods. Frequently the first two groups are combined into one group of potential methods; the electromagnetic methods are usually subdivided into galvanic-electromagnetic and inductive-electromagnetic.

Self-potential method. The self-potential method is the only electrical method in which a natural field is observed; its causes are spontaneous electrochemical phenomena. These phenomena occur on ore bodies and on metallic minerals and placers; they are produced by corrosion of pipe lines and on formation boundaries in wells by differences in the conductivity of drill-

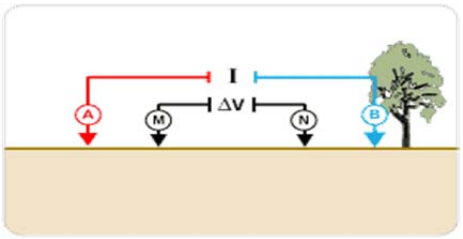
ing fluid and formation waters. Ore bodies whose ends are composed of materials of different solution pressure and are in contact with solutions of different ion concentration, act as wet cells and produce an electrical field which can be detected by surveying equipotential lines or potential profiles. For the mapping of equipotential lines, a high-resistance milliammeter is connected to two unpolarizable electrodes are used. One is kept stationary and the other is moved until the current vanishes. At that point the electrodes are on an equipotential line.

Equipotential-line and potential-profile methods



Equipotential lines of the current

When a source of electrical energy is grounded at two points, an electrical field is produced. Distortions of this field result from the presence of bodies of different conductivity; good conductors will attract the lines of flux, and vice versa. As it is difficult to survey these lines of flux, lines of equal potential, that is, lines along which no current flows, are mapped instead. In practice power is supplied to two grounded electrodes from an alternating current generator.



Resistivity methods.

Equipotential-line methods, while useful for the mapping of vertical or steeply dipping geologic bodies, are not suited to the investigation of horizontally stratified ground. Conversely, resistivity methods are applicable to depth determinations of horizontal strata and the mapping of dipping formations.

In resistivity procedures not only the potential difference between two points but also the current in the primary circuit is observed. The ratio of potential difference and current, multiplied by a factor depending on electrode spacing, gives the resistivity of the ground.

Potential-drop-ratio methods. The essential feature of the resistivity methods is a determination of the potential difference between two points at the surface and a measurement of the current in the external circuit. In potential-drop-ratio methods current measurements in the external circuit are not made and the potential drops in two successive ground intervals (represented by three stakes arranged in a straight line, radiating from one of the power electrodes) are compared. The potential-drop-ratio method is best suited for the location of vertical formation boundaries (faults, dikes, veins, and the like).

Electromagnetic-galvanic methods. Electromagnetic methods of electrical prospecting differ from potential methods in that the electromagnetic field of ground currents and not their surface potential (electric field) is measured. They fall into two major groups: (1) electromagnetic-"galvanic" methods in which the primary energy is supplied by contact as in the potential methods; (2) electromagnetic-"inductive" methods in which the ground is energized by inductive coupling (with insulated loops). To supply electrical energy to the ground by contact, line electrodes are laid out at right angles to the strike, point electrodes parallel with the strike.

Electromagnetic-inductive methods. In inductive procedures power is supplied to the ground by insulated loops which will cause induction currents to flow in subsurface conductive bodies. An advantage of inductive methods is the ease with which power may be transferred into the ground when the surface formations are poor conductors. Since currents induced in the subsurface conductors are dependent on frequency, interpretative advantages may be gained by regulating the frequency.

Abridged from C.A. Heiland. Geophysical Exploration. New York, 1968

TEST 2

Variant 2

READING

I. Read the text and match the headings (1–5) with the paragraphs (A–E).

1. Geochemical surveying ____
2. Seismic surveying ____
3. Magnetic surveys ____
4. Gravimetric surveys ____
5. Electric surveys ____

SURVEYS

A. _____ measure variations in the Earth's magnetic field caused by magnetic properties of subsurface rock formations. In prospecting for metallic minerals, these techniques are particularly useful for locating magnetite, pyrrhotite and ilmenite. Electromagnetic surveys are based on variations of electric conductivity in the rock mass. An electric conductor is used to create a primary alternating electromagnetic field. Induced currents produce a secondary field in the rock mass. The resultant field can be traced and measured, thus revealing the conductivity of the underground masses. Electromagnetic surveys are mainly used to map geological structures, and to discover mineral deposits such as sulphides containing copper or lead, magnetite, pyrite, graphite, and certain manganese minerals.

B. _____ measure either the natural flow of electricity in the ground, or "galvanic" currents led into the ground and accurately controlled. Electrical surveys are used to locate mineral deposits at shallow depth and map geological structures to determine the depth of overburden to bedrock, or to locate the groundwater table.

C. _____ measure small variations in the gravitational field caused by the pull of underlying rock masses. The variation in gravity may be caused by faults, anticlines, and salt domes that are often associated with oil-bearing formations. Gravimetric surveys are also used to detect high-density minerals, like iron ore, pyrites and lead-zinc mineralizations. In regions where rock formations contain radioactive minerals, the intensity of radiation will be considerably higher than the normal background level. Measuring radiation levels helps locate deposits containing uranium, thorium and other minerals associated with radioactive substances.

D. _____ is based on variations of sound velocity experienced in different geological strata. The time is measured for sound to travel from a source on surface, through the underlying layers, and up again to one or more detectors placed at some distance on surface. The source of sound might be

the blow of a sledgehammer, a heavy falling weight, a mechanical vibrator, or an explosive charge. Seismic surveys determine the quality of bedrock, and can locate the contact surface of geological layers, or of a compact mineral deposit deep in the ground. Seismic surveys are also used to locate oil-bearing strata.

E. _____ is another exploration technology featuring several specialities, the main one being to detect the presence of metals in the topsoil cover. By taking a large number of samples over an extended area and analyzing the minute contents of each metal, regions of interest are identified. The area is then selected for more detailed studies.

Abridged from: Mining Methods in Underground Mining. 2nd Ed. – AtlasCopco, 2007

II. Read about the text about electromagnetic waves. Write whether the following statements are true (T) or false (F).

Statement	True/False (T/F)	
1. The lamp producing sterilizing radiation has been applied to surgery.		
2. The coil carrying the current remains quite cold.		
3. Waves between 100 and 1000 miles in length can be used to melt metals without flame.		
4. The metal is placed into a crucible which is inside the solenoid generating the waves.		
5. Very long electromagnetic waves are also employed to examine the structure of the moon.		
6. The method of electromagnetic waves is often used in geophysical prospecting.		

THE USE OF ELECTROMAGNETIC WAVES

Many experiments having been conducted to discovery of the best types of radiation, a lamp producing sterilizing radiation was developed. The lamp has been applied to surgery, the radiation having been shown to be harmless to human flesh. By bathing the operating table in the rays it is possible to ensure sterility, its principle being the exclusion of germs in the modern operating theater.

An interesting use is made of longer waves. Waves between 10 and 100 miles in length can be used to melt metals without flame. The metal is placed into a crucible which is inside the solenoid generating the waves. The latter being led into the metal, their absorption sets up secondary currents which result in heating the metal until it melts. The coil carrying the current remains quite cold. On the same principle it is possible to cook the dinner in

a cold oven. A kettle may be boiled on ice. In the same way fish were cooked in water remaining perfectly cold.

Very long electromagnetic waves are also employed to examine the structure of the earth. The waves having a length of about 25 miles are sent downwards. When encountering a metallic ore body, they are absorbed and electromagnetic field is set up. This can be measured on the surface of the earth and as a result of these measurements it is possible to indicate the direction and depth of the ore. This method is often used in geophysical prospecting.

III. Read the text below and answer the questions.

1. What does the method of mining mineral deposits underground involve?
2. What main requirements should mining methods satisfy?
3. What are the main disadvantages of shortwall faces?
4. What is the main advantage of long continuous faces?
5. What methods of mining long faces do you know?
6. Do short faces or long faces predominate in Russia?
7. What can you say about the Ruhr coal-field?

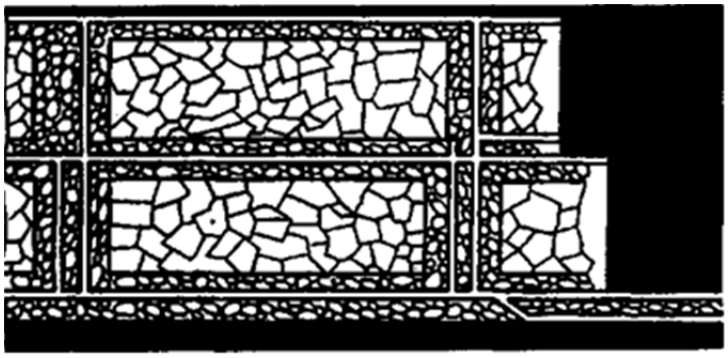
Methods of Working Bedded Deposits Underground

The method of working (or method of mining) includes a definite sequence and organization of development work of a deposit, its openings and its face work in certain geological conditions. It depends on the mining plan and machines and develops with their improvements.

A rational method of working should satisfy the following requirements in any particular conditions: 1) safety of the man; 2) maximum output of mineral; 3) minimum development work (per 1,000 tons output); 4) minimum production cost and 5) minimum losses of mineral.

Notwithstanding the considerable number of mining methods in existence, they can be reduced to the following main types: 1. Methods of working with long faces (continuous mining); 2. Methods of working with short faces (room-and-pillar).

Longwall advancing

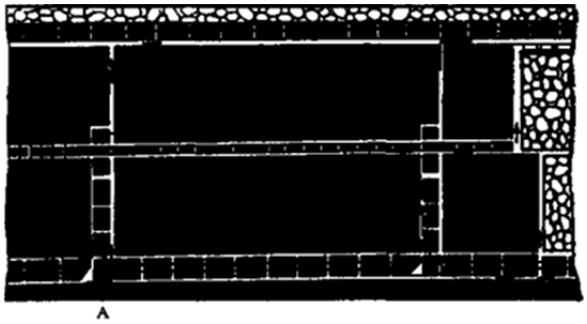


The characteristic feature of the continuous mining is the absence of any development openings made in advance of production faces. The main advantage of long continuous faces is that they yield more mineral. Besides, they allow the maximum use of combines (shearers), cutting machines, powered supports and conveyers. The longwall method permits an almost 100 per cent recovery of mineral instead of 50 to 80 per cent obtainable in room-and-pillar methods.

The basic principle of room-and-pillar method is that rooms from 4 to 12 metres wide (usually 6–7) are driven from the entries, each room is separated from each other by a rib pillar. Rib pillars are recovered or robbed after the rooms are excavated. The main disadvantage of shortwall work is a considerable loss of mineral and the difficulty of ventilation. In working bedded deposits methods of mining mentioned above may be used either with stowing or with caving.

In Russia, Germany (the Ruhr coal-field), France and Belgium nearly all the faces are now long ones. In Britain longwall faces predominate.

Longwall retreating by long panels



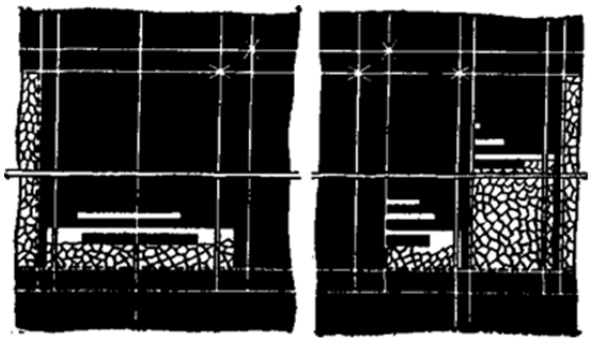
The USA, Canada, Australia and to some extent India are developing shortwall faces and creating the machines for them. In these countries shortwall faces are widely used.

In Russia the thick seams are taken out to full thickness up to 4,5 m thick if they are steep, and up to 3,5 m thick if they are gently sloping or inclined. In the Kuznetsk coal-field long faces are worked to the dip with a shield protection, using a method proposed by N. Chinakal. In shield mining coal is delivered to the lower working by gravity so that additional haulage is not required.

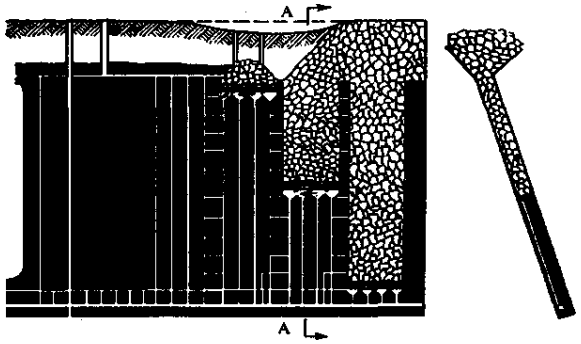
It should also be noted that in Russia hydraulic mining is widely used as it is one of the most economic and advantageous methods of coal getting. New hydraulic mines are coming into use in a number of coal-fields. Hydraulic mining is developing in other countries as well.

The aim of hydraulic mining is to remove coal by the monitors (or giants) which win coal and transport it hydraulically from the place of work right to the surface.

Room-and-pillar method for working a gently sloping seam



It is quite obvious that the choice of the method of mining will primarily depend on the depth and the shape and the general type of the deposit.



Shield method of working

Abridged from: Barakova M.Ya., Zhuravleva R.I. English for mining engineers. Moscow, 2001.

VOCABULARY AND TERMINOLOGY

IV. Read the text Methods of Working Bedded Deposits Underground in detail and match the English word-combinations (1–10) with the Russian equivalents (a–j).

1)	development face	a)	сплошная система разработки
2)	great losses	b)	выемка целиков
3)	shield method of mining	c)	подготовительный забой
4)	continuous mining	d)	большие потери
5)	longwall advancing to the dip	e)	удовлетворять требованиям
6)	the room-and-pillar method of mining	f)	зависеть от геологических условий
7)	to open up a deposit	g)	выемка лавами прямым ходом по падению
8)	pillar mining	h)	щитовая система разработки
9)	to satisfy the requirements	i)	вскрывать месторождение
10)	to depend upon the geological conditions	j)	камерно-столбовая система разработки

V. For questions 1–6, choose one of the words (a–f) that best completes a gap in the text.

a)	**sublevel**	**c)**	**caving**	**e)**	**shrinkage**
b)	**cut-and-fill**	**d)**	**longwall**	**f)**	**stull**

Subsurface Mining Methods

Every subsurface mining method has advantages. But there is no method that is right for every mine. Learn about the advantages of each method. Then you can choose the right one.

Unsupported Methods

The unsupported method does not require a large workforce. For small mines, (1) _____ stoping is a good option. Do you need to keep mining costs low? Then try (2)_____ stoping.

Supported Methods

(3)_____ stoping is one of the safest mining methods. For ores of various shapes and depths, square-set stoping is a good choice. (4) _____ stoping is possible without too many expensive machines.

Caving Methods

(5) _____ mining is good for mining very deep seams. Meanwhile, with block (6) _____, it's possible to recover up to 90 % of ore.

Abridged from: Virginia Evans, Jenny Dooley, Kenneth Rodgers. Career Paths: Natural Resources II — Mining (Student's Book). Express Publishing, 2014

VI. Fill in the gaps with the given derivatives.

magnet magnetic magnetism magnetization advantage disadvantage

1. As for the room-and-pillar method one must say that this method of mining is seldom practiced in Russia because it has some _____s.
2. _____s are used to attach the toy train's cars to the engine.
3. One of these _____s is that the pillars between the rooms are partly extracted.
4. Researches on _____, electricity, heat, light, crystallization, and chemical attraction, in their relation to the vital force.
5. The _____ field has no influence since it is parallel to the normal of the bow shock.
6. The _____ occurs parallel to the axis of spin.

VII. Complete sentences using the only one word.

1. Sterilizing radiation is harmless to human _____.
2. The absorption of waves in a crucible ____ secondary currents.
3. An electric _____ is used to create a primary alternating electromagnetic field.

4. Electromagnetic waves are also employed to examine _____ of the Earth.
5. When the waves encounter a metallic ore body, they are absorbed and electromagnetic ____ is set up.
6. The main advantage of long continuous faces is that they yield more _____.
7. _____ mining is widely used in Russia as it is one of the most economic and advantageous methods of coal getting.
8. _____ mining is good for mining very deep seams.

VIII. Match the term (1–10) with the definition (a–j).

1)	stoping	a) is a method of underground mining used in vertical stopes and in mining high-grade irregular ore bodies.
2)	longwall mining	b) is the removal of deposits from the earth by drilling underneath layers of rock and dirt. These deposits are difficult to reach from the surface and require the drilling of vertical or horizontal shafts for access.
3)	block caving	c) is an underground hard rock mining method that involves undermining an ore body, allowing it to progressively collapse under its own weight.
4)	stull stoping	d) is a mining method used for steeply dipping, narrower ore bodies with self supporting walls and ore.
5)	cut-and-fill stoping	e) is a method of mining used to extract minerals and metals which are near the surface of the Earth. There are three basic types of surface mining: open pit mining, strip mining, and quarry mining.
6)	surface mining	f) is a mining method that involves vertical mining in a large, open stope that has been created inside an ore vein. Drilling, blasting, and mining are carried out at different elevations in the ore block.
7)	shrinkage stoping	g) is the process of extracting the desired ore or other mineral from an underground mine, leaving behind an open space known as a stope.
8)	room and pillar method	h) is a form of underground coal mining where a long wall of coal is mined in a single slice (typically 0,6–1,0 m thick).
9)	sublevel stoping	i) is a mining system in which the mined material is extracted across a horizontal plane, creating horizontal arrays of rooms and pillars. The ore is extracted in two phases.
10)	subsurface mining	j) is a form of stoping used in hardrock mining that uses systematic or random timbering (stulls) placed between the foot and hanging wall of the vein.

GRAMMAR

IX. Match the parts of the sentences to form the conditional sentences.

1. We would have made a cake	a) if he hadn't shouted at them.
2. If it rains much	b) if she loses weight.
3. If I knew English well	c) if we had bought some eggs yesterday.
4. My kids wouldn't have cried	d) if I were you.
5. I would call him	e) I would be an interpreter.
6. She will put this dress on	f) the flowers will grow very fast.

X. Make up conditional sentences. The situations are given. Mind mixed conditionals.

1. I shall go to the dentist because I have a toothache. If ___.
2. He is groaning with pain now because he did not go to the dentist to have his tooth filled. If ___.
3. She does not go to the polyclinic because she does not need any treatment. If ___.
4. He will not go to see the play as he was present at the dress rehearsal. If ___.
5. He went to Moscow specially to hear this famous singer because he is fond of him. If ___.
6. We did not go to the cafeteria to have a glass of lemonade because we were not thirsty. If ___.

TRANSLATION

XI. Translate the following conditional sentences into Russian.

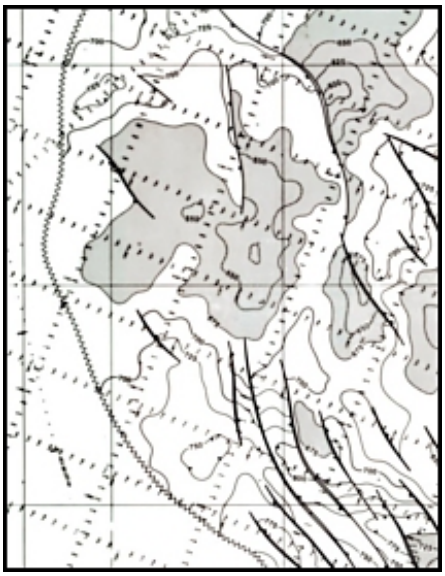
1. Had our research been successful, we should have been able to investigate composition of Mars' atmosphere.
2. Were it possible to squeeze matter together until the nuclei touch one another, then the entire earth could be compressed to the size of a football.
3. Many accidents could have been prevented, had the principles of physics been known and properly applied.
4. Should the pressure of gas be doubled, the volume would become half provided the temperature is not permitted to change.
5. We shouldn't be able to demonstrate the flow of water in a pipe unless we installed a pump somewhere in the pipeline.
6. If germanium had not been properly purified, it would not have suited for transistors.
7. Provided the molecules of water had been divided into smaller parts, it wouldn't have been water any longer but some other substance.
8. If you studied the physics of semiconductors, you would know the properties of the p-n junction.

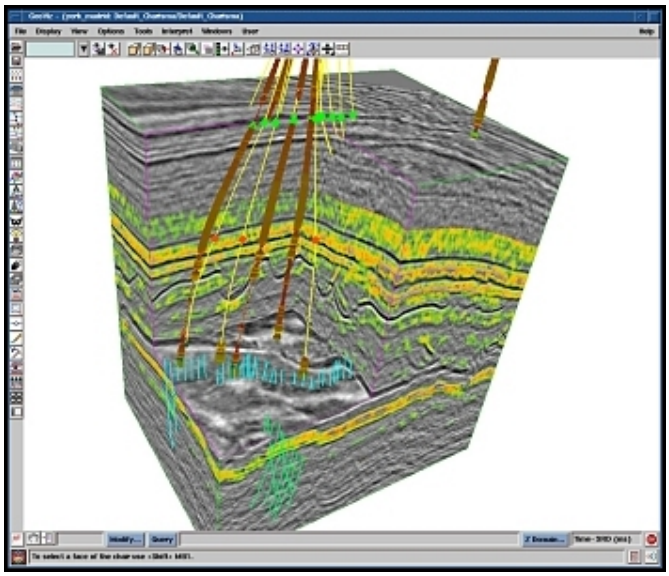
WRITING

XII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176).

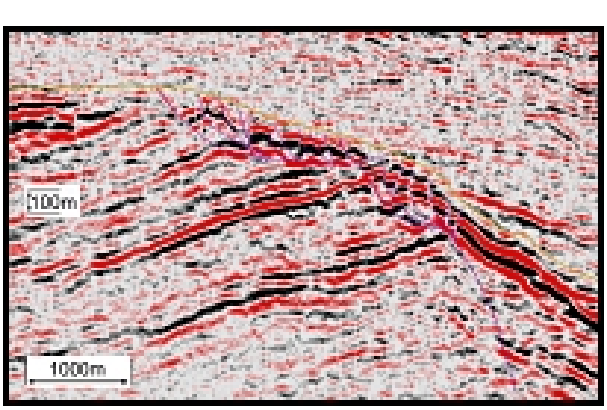
Latest developments

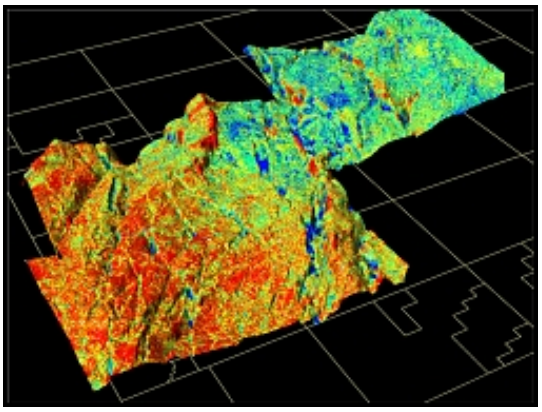
Recent increases in computing capacity have enabled the migration process to be applied before stack, i. e. on the vast amounts of data collected in the acquisition phase. This pre-stack depth migration (PSDM) application is critical in areas with complex geological subsurface structures, such as around/below salt domes and other high-velocity layers. This has led to the first reliable seismic images of sediments located below such complicated overburden structures.





Because of the greatly improved seismic resolution of 3D seismic imaging, there has been an effort to reduce the cost of 3D data acquisition and shorten the time it takes to acquire and process the large volumes of data acquired. In the past it could take up to 24 months to process the recordings from a 3D survey. Acquisition time has been cut by specially designed survey vessels deploying up to ten multiple streamers at a time, or by using multiple vessels. These techniques allow a swath of seismic data to be acquired in the same time it previously took to record a single 2-dimensional line. Specially designed paravanes steer the cables away from each other. Their design reduces the drag of the streamer array, which ordinarily would be sufficient to stop even quite a powerful vessel. Modern streamers have multiple global positioning system (GPS) sensors that constantly record the position of the streamers relative to the vessel and the earth.





New techniques of data compression are being tried to allow the transmission of the raw seismic records from the acquisition vessel to the shore for immediate processing, in an effort to get the data to the interpreters faster.

Improved resolution and reduced acquisition/processing times have opened up the possibility of shooting seismic at different time intervals over the same area of a producing field, in order to detect changes. These changes with time will clarify how a field is behaving by revealing exactly where the fluids are or are not moving, or by revealing changes in pressure in different parts of the field, thereby indicating how production might be improved. This is the so-called 4D or time-lapse seismic, where time is essentially the "fourth dimension". Results in recent years have been quite astonishing.

If seismic is to be acquired at regular intervals over the same field, then it can be economic to permanently install an array of hydrophones on cables buried just beneath the seafloor. BP has done this in the Foinaven field, for example, with the aim of shooting over the array with a seismic vessel once a year.

Another recent development is that visualization has been taken to a new level with the advent of Virtual Reality rooms, allowing 3D subsurface images to be displayed on large screens and to be viewed from almost any angle. Different development options, such as the impact of various drilling targets, can be simulated. Much of the benefit of this approach stems from the fact that communication and understanding are greatly enhanced when multi-discipline teams meet whilst "immersed" in such an environment.

Abridged from: Discovering the Underground Structure http://www.ukooa.org/education/storyofoil/index.cfm)

TEST 2

Variant 3

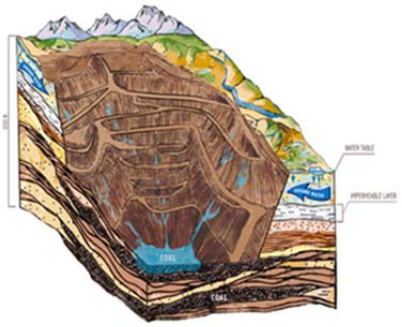
READING

I. Read the text and match the headings (1–5) with the paragraphs (A–E).

1. Mountaintop removal ____
2. Dredging ____
3. Open-pit mining ____
4. High wall mining ____
5. Strip mining ____

TYPES OF SURFACE MINING

A. This process involves the method of extracting the mineral by removing soil and rock which are deposited on the surface. Coal and Lignite are the two principle minerals that are extracted through this method. This kind of mining can be done when the mineral to be extracted almost near to the surface. This process is divided into area stripping and contour stripping. This method of striping is common on flat land to extract the mineral over a large area.



B. This type of mining involves the extraction of rock or minerals from the earth by forming an open pit. This process differs from the other method which requires digging into the earth. This method of mining is carried out where useful minerals or rocks are found near the surface. When the surface material covering the valuable material is relatively thin this kind of mining is more suitable.

Open cast mines are dug on benches which are usually four to sixty meter intervals and the machinery used depends on the size of the area. The flat part of the wall is known as the bench whereas the inclined portion of the sections is known as batter. To prevent the damage from rock falls the walls of the pit has to be dug on less than vertical angle.

A crude, temporary road is usually found at the side of the pit for the movement of trucks carrying ore or waste rocks. The waste rocks are always piled up on the borders of the open pit. This waste dump is arranged in rows and stepped to lower the degradation.

C. Another method involved in this category aims at mining the summit or the long and narrow edge of the mountain. The main mineral extracted by this method is coal. Coal is mined by removing the land above the seams. This method of coal mining is mainly conducted on the Appalachia Mountain in the United States.

The coal cannot be mined using simple machines. Explosives are used to mine the coal and the excess coals are dumped in the nearby valley. This method is less expensive and requires only a few employees. There is controversy as to whether the coal mining is safe as it is being removed from the mountain top. But the coal industry asserts that it is safer than the underground mining.

D. This is a method by which underwater minerals are extracted. It is usually used to make waterways for boats and navigation canals for the passage of container ships to save time. The mineral can be extracted from under water in cheap and efficient way. Oil refining is done mainly by this method.

E. In the following method the Hydraulic Push – beam Transfer Mechanism is used to cut across the earth's surface and extract the coal. In this pro-

cess the machine penetrates deep into the earth's surface to produce large volume of coal. High wall miners have penetrated to the depth of around a thousand feet into the coal seam and capable of going further with the support of advanced techniques. High wall mining accompanied by water pumping and proper mapping can produce large quantities of coal, however the cost of production is also higher compared to other forms of mining.

Abridged from: https://www.greatmining.com/Surface-Mining.html

II. Read about the text about SURFACE MINING. Write whether the following statements are true (T) or false (F).

Statement	True/False (T/F)	
1. Surface mining is a form of mining in which the required mineral deposits are removed through shafts or tunnels.		
2. Surface mines are naturally extended until either the valuable deposit is exhausted.		
3. The mining takes place in the forested areas.		
4. About 70 percent of the world minerals extracted from the earth are through underground mining.		
5. The method of surface mining removes soil and rock overlying the mineral deposit.		
6. The equipment used for this process is always heavy such as earth movers, dragline excavators or bucket wheel excavators.		

SURFACE MINING

Surface mining is a form of mining in which the soil and the rock covering the mineral deposits are removed. It is the other way of underground mining, in which the overlying rock is left behind, and the required mineral deposits are removed through shafts or tunnels.

Surface mining is basically employed when deposits of commercially viable minerals or rock are found closer to the surface; that is, where over-

strain (surface material covering the valuable deposit) is relatively very less or the material of interest is structurally unsuitable for heavy handling or tunneling (as would usually be the case for sand, cinder, and gravel).

Where ever minerals occur deep below the earths crest or the overburden is too thick or the mineral occurs as strands in hard rock. Underground mining methods are employed to extract the valuable mineral deposits.

Surface mines are naturally extended until either the valuable deposit is exhausted, or the cost of decresting larger volumes of overburden makes further mining an uneconomic option to shoulder.

In most types of surface mining, heavy paraphernalia's such as earthmovers are utilized. They 1st remove the overburden the soil and rock above the deposit. Then followed by the huge machines, such as dragline excavators, extract the mineral.

It is a known fact that Mother Earth contributes largely to the wealth of the world. The mining takes place in those areas where the growth of vegetation is very minimal or at times does not exist due to the surface conditions. The most important method used to extract the minerals from the earth is surface mining. It is surprising to notice that 70 percent of the minerals extracted from the earth are through this process. The basic material used for construction purposes like crushed rocks, sand and gravel is obtained through this method.

After the discovery of certain kinds of mineral deposits in a particular area a method has to be evaluated to extract these minerals. The selection is based on technical and environmental aspects and surface mining is preferred to extract the minerals from the surface area. As compared to underground mining this method of mining removes soil and rock overlying the mineral deposit. The equipment used for this process is always heavy such as earth movers, dragline excavators or bucket wheel excavators.

Abridged from: https://www.greatmining.com/Surface-Mining.html

III. Read the text below and answer the questions.

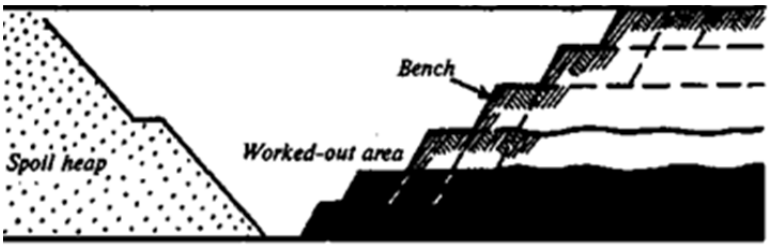
1. What deposits can be extracted by the open-cast method?
2. What is called an opencast?
3. What is the difference between a trench and an opencast?
4. In what case is it necessary to use explosives to break mineral?
5. Is hydraulicking used only in open-cast mining?
6. What equipment is used in hydraulicking?
7. What transport systems are used in opencasts?
8. Where is waste rock dumped?

OPEN-CAST MINING

Minerals at shallow depths are extracted by open-cast mining which is cheaper than underground mining. Open-cast mining consists in removing the overburden, and other strata that lie above mineral or fuel deposits to recover them.

Opencasts or open-pit mines are in fact quarries for getting coal or metalliferous minerals. In the USA opencasts are called strip mines (strip pits).

All the surface excavations, waste heaps and equipment needed for extracting mineral in the open form an independent mining unit. An opencast is a long, wide and comparatively shallow working though it can reach 200 m or even more in depth.



Open-cast working

In opencasts the excavation is by horizontal slices corresponding to the type of mineral or overburden in slice. In the picture above one can see the benches (or slices). A bench is a thickness of rock or mineral which is separately broken or excavated. Other open workings are called trenches, which are long, narrow, shallow exploratory workings.

The whole production process in opencasts can be divided into the following basic stages: 1) preparing the site to be worked; 2) de-watering it and preventing inflows of water to the site; 3) providing access (entry) to the deposit by the necessary permanent investment; 4) removal of overburden (stripping); 5) mineral excavation.

Stripping the overburden and mineral production include breaking rock or mineral, transporting it and loading it. Minerals can often be dug directly by earth-moving equipment, while to break hard rocks it is necessary to use explosives.

Modern methods of working opencasts involve the use of mechanical plants or hydraulicking. The basic units of a mechanical plant are excavators, car drills or other mounted drills, and various mechanical handling equipment whereas the basic units of hydraulicking are monitors, pumps such as sludge pumps or gravel pumps. Hydraulicking can be used in soft or friable ground.

Transport operations involve the removal of waste rock or mineral, the latter being transported to coal washeries, ore concentration plants, to power stations, or to a railway station. Waste rock is removed to a spoil heap or

dump (tip) either outside the deposit or in an extracted area, these being called external or internal dumps, respectively.

The transport used in opencasts are rail cars, large lorries, and conveyers. Sometimes the overburden is stripped and dumped by excavators without other transport, in overcasting or sidecasting. Mineral is usually unloaded at specially equipped permanent stations. Waste rock is dumped at various points which are moved as the work develops.

Abridged from: Barakova M.Ya., Zhuravleva R.I. English for mining engineers. Moscow, 2001.

VOCABULARY AND TERMINOLOGY

IV. Read the text OPEN-CAST MINING in detail and match theEnglish word-combinations (1–10) with the Russian equivalents (a–j).

1)	to consume energy	a)	автоматический опрокид
2)	friable roof	b)	не говоря о (чём-л.)
3)	waste heap (spoil heap)	c)	перфоратор на колонке
4)	overcasting	d)	слоевая система разработки
5)	sludge and gravel pumps	e)	слабая кровля
6)	automatic dumper	f)	потреблять энергию
7)	mounted drill	g)	отвал, терриkон
8)	not to mention	h)	песковый и шламовый насосы
9)	explosives	i)	взрывчатые вещества
10)	slicing method	j)	перелопачивание

V. For questions 1–6, choose one of the words (a–f) that best completes a gap in the passage

a)	**overburden**	**c)**	**outcrop**	**e)**	**access**
b)	**sewage**	**d)**	**pit**	**f)**	**benches**

MEMO

from: Mr. Gregg Williams
To: All board members of Manderton Mining
Re: Red Hill Mine

Crews have located an **(1)**_____. It will guide us when we begin digging the main **(2)**_____. Teams are estimating depth for **(3)**_____, the ideal depth which will allow us to reach the targeted area of the coal face. Access ramps and berms will be built as digging progresses.

We started constructing haulage roads. Crews are also placing the lining for the **(4)_____** lagoon. The crews need to complete their estimates on how large the pit will be. Then we can select a site for the waste dumps for waste rock. Crews also need to estimate the amount of **(5)_____**.

We are waiting for permission from the city. Then we can build access roads from the highway to the actual site. Work on the main office and storage facilities will also begin once the **(6)_____** roads are built.

Abridged from: Virginia Evans, Jenny Dooley, Kenneth Rodgers. Career Paths: Natural Resources II — Mining (Student's Book). Express Publishing, 2014.

VI. Fill in the gaps with the given derivatives.

mine miner mining dig digger digging

1. We may _____, study, and scrutinize every part of Stonehenge but we will never know all of the secrets of the ancient megalith known as Stonehenge.
2. Major industries include _____ and aluminum processing, forestry and the manufacture of beverages.
3. But as new coal _____s are developed, prices will ease somewhat.
4. After these goldrushes, and the return of experienced, but mostly unsuccessful _____s, gold, copper, and silver mines were in production within a short time
5. He was leader of the _____s' union.
6. Archaeologists _____ in Jerusalem uncovered a piece of pottery inscribed with the name Goliath.

VII. Complete sentences using one word or a phrase from the box.

outcrop	**surface mining**	**sewage lagoon**	**bench**
access road	**waste dump**	**overburden**	**waste rock**

1. The _____ was stored in a dump until it could be moved elsewhere.
2. The _____ guided the team as they dug the pit.
3. The crew removed several tons of _____ before they accessed the ore.
4. Waste water is stored in the _____ .
5. The miners stood on the _____ while they worked.
6. The mine needs more space for a _____ where unneeded materials are kept.
7. I understand that work on the construction of the _____ has now been started.
8. _____ is a broad category of mining in which soil and rock overlying the mineral deposit (the overburden) are removed.

VIII. Match the terms (1–10) with the definitions (a–j).

1)	adit	a)	a thickness of rock or mineral which is separately broken or excavated.
2)	stope	b)	a surface of which one end or side is at a higher level than another; a rising or falling surface
3)	overburden	c)	a horizontal passage leading into a mine for the purposes of access or drainage.
4)	bench	d)	an excavation in a mine working or quarry in the form of a step or notch.
5)	slope	e)	a large deep hole from which stones or minerals are quarried.
6)	explosive	f)	a horizontal or inclined passage following a mineral vein or coal seam
7)	removal	g)	rock or soil overlying a mineral deposit, archaeological site, or other underground feature.
8)	drift	h)	a long cylindrical rotating rod for the transmission of motive power in a machine.
9)	pit	i)	an action of taking away or abolishing something unwanted.
10)	shafts	j)	a substance which can be made to explode, especially any of those used in bombs or shells.

GRAMMAR

IX. Complete the sentences to form conditionals.

1. If I __ (to be) at home, I will learn my new words.
2. If John has the book, he __ (to lend) it to me.
3. If you __ (to come), you would see him.
4. Mary will help you, if she __ (to get) more pocket money.
5. I __ (to tell) you, if you asked me.
6. He __ (to wash) it, if you give him some soap.
7. If you use it, nobody __ (to see) you.
8. If we __ (to eat) enough, we wouldn't be hungry.
9. If you __ (to get) up early, you would catch the train.
10. If I have some money, I __ (to buy) a new computer.

X. Write down each sentence three times to form conditionals of type 1, 2, and 3.

Example: *If you (to be) free, I (to come) to see you.*
If you are free, I shall come to see you. (type I)
If you were free, I should come to see you. (type II)
If you had been free, I should have come to see you. (type III)

1. If you (to be) busy, I (to leave) you alone.
2. If my friend (to come) to see me, I (to be) very glad.
3. If we (to receive) a telegram from him, we (not to worry).
4. If you (not to work) systematically, you (to fail) the exam.

TRANSLATION

XI. Translate the sentences into Russian.

1. If just one soil nutrient, such as nitrogen, is missing or below optimal levels, fewer healthy wheat plants will grow.
2. If the concentration of these gases rises, they trap more heat within the atmosphere, causing worldwide temperatures to rise.
3. If plankton populations decline, it may lead to increased carbon dioxide levels in the atmosphere and thus to global warming.
4. Even if the manufacture of CFCs is immediately banned, the chlorine already released into the atmosphere will continue to destroy the ozone layer for many decades.
5. Even if the most stringent prohibitions against CFCs are implemented, however, scientists expect that it will take at least 50 more years for the hole over Antarctica to close completely.
6. It is expected these fuels will be tested in actual engines by 2005, if not sooner.
7. While the water would be anything but warm if you jumped into it, it is at least around 30° F, its salt water stays liquid at a lower temperature than fresh water.
8. It would have saved you a lot of time if you had prepared for your experiment more carefully.

WRITING

XII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176)

CORE DRILLING

Core drilling yields a solid cylinder shaped sample of the ground at an exact depth and is also used to define the size and the exact borders of mineralization during the lifetime of the mine. This is important for determining ore grades being handled, and vital for calculating the mineral reserves that will keep the mine running in the future. A strategically-placed underground core drill may also probe for new ore bodies in the neighborhood.

In 1863, the Swiss engineer M. Lescot designed a tube with a diamond set face, for drilling in the Mount Cenis tunnel, where the rock was too hard for conventional tools. The intention was to explore rock quality ahead of the

tunnel face, and warn miners of possible rock falls. This was the accidental birth of core drilling, a technique now very widely used within the mining industry. Core drilling is carried out with special drill rigs, using a hollow drill string with an impregnated diamond cutting bit to resist wear while drilling hard rock. The crown-shaped diamond bit cuts a cylindrical core of the rock, which is caught and retained in a double tube core-barrel.

A core-catcher is embedded in, or just above, the diamond bit, to make sure that the core does not fall out of the tube. In order to retrieve the core, the core-barrel is taken to surface, either by pulling up the complete drill string or, if the appropriate equipment is being used, by pulling up only the inner tube of the core-barrel with a special fishing device run inside the drill string at the end of a thin steel wire.

The core is an intact sample of the underground geology, which can be examined thoroughly by the geologist to determine the exact nature of the rock and any mineralization. Samples of special interest are sent to a laboratory for analysis to reveal any metal contents.

Cores from exploration drilling are stored in special boxes and kept in archives for a long period of time. Boxes are marked to identify from which hole, and at what depth, the sample was taken. The information gathered by core drilling is important, and represents substantial capital investment. Traditionally, core drilling was a very arduous job, and developing new techniques and more operator-friendly equipment was very slow, and the cost per drilled meter was often prohibitive. Atlas Copco Geotechnical Drilling and Exploration pioneered several techniques to reduce manual work, increase efficiency and cut the cost per drilled meter.

Over the years, the company developed thin walled core barrels, diamond impregnated bits, aluminum drill rods, fast rotating hydraulic rigs, mechanical rod handling, and, more recently, partly or totally computer-controlled rigs. Core drilling has always been the most powerful tool in mineral exploration. Now that it has become much cheaper, faster and easier, it is being used more widely.

Abridged from: Mining Methods in Underground Mining. 2nd Ed. – AtlasCopco, 2007.

TEST 2

Variant 4

READING

I. Read the text and match the headings (1–4) with the paragraphs (A–D).

1. Crude oil classification ____
2. Crude oil composition ____
3. Forms of unconventional oil ____
4. Crude oil properties ____

WHAT IS CRUDE OIL?

A. Crude oil is a liquid found naturally in rock, containing mostly complex hydrocarbons, with some additional organic material. It is the major fuel used on the planet, and is used in the production of many synthetic materials like plastics as well.

This oil can come in many different weights and colors, and can differ greatly in its composition. As little as half of the composition of heavy oils can be made up of hydrocarbons, while the lightest oils can be up to 97% hydrocarbons. There are four main hydrocarbons found in crude oil, in varying amounts depending on the oil. Around half of the hydrocarbons in most unrefined oil are naphthenes, one-third are paraffins, one-sixth are aromatics, and the rest are asphaltics. The color can range from pure black or dark brown to greenish or yellowish, depending on the composition.

B. Crude oil is considered light if the level of hydrocarbons relative to organics and metals is high, making its density low, and it is considered heavy if the level of hydrocarbons relative to organics and metals is low, making its density as high. Additionally, unrefined oil is classified as sweet if it has very little sulfur in it, and is classified as sour if it has a great deal of sulfur in it. So a crude oil will usually be called something like a sweet, light oil, or a sour, heavy oil. Sweeter oils are more valuable than sour oils, because most countries have sulfur regulations for environmental reasons, and sweet oils require less treatment to remove the sulfur. Light oils are more valuable than heavy oils, because more gasoline can be created from a smaller amount.

C. Different regions on earth tend to have different types of oil, so unrefined oil is often classified based on where it comes from. Certain regions will act as a sample of a broader region, since they are seen as relatively representative of that broad region. For example, Dubai-Oman oil is a sour crude oil, and is used to benchmark most sour crude from the Middle East; West Texas Intermediate is a sweet, light oil; and the OPEC Reference Basket is a composite oil sample that averages oils from all over the Organization of the Petroleum Exporting Countries.

D. While conventional unrefined oil is currently the major source of petroleum on the planet, it actually makes up a minority of crude oil currently in reserve. A bit less than one-third of the unrefined oil known on the planet is in conventional form. Another one-sixth is a heavy oil, and a quarter is extra-heavy oil. Another one-third, roughly equal to the amount of conventional oil, is in the form of oil sands, or crude bitumen. This is not a liquid form of crude oil, but is mixed with sand into a somewhat solid form. Huge reserves of bitumen can be found in Venezuela and Canada, which also contain large amount of extra-heavy oil, making the two countries' reserves equal to about twice the known reserves of conventional oil.
Abridged from: https://www.wisegeek.com/what-is-crude-oil.htm

II. Read about the text about oil properties. Write whether the following statements are true (T) or false (F).

Statement	True/False (T/F)	
1. Due its properties, oil is uniquely irreplaceable as a lubricant for vehicular and other machinery use.		
2. Commercial motor oil is largely a mixture of hydrocarbons – non-organic compounds made of hydrogen and carbon.		
3. Crude oil composition depends on its geographic origin.		
4. Oil is the product resulting from the refinement of crude oil.		
5. Some of oil beneficial properties include the inhibition of corrosion of metal surfaces as well as the removal of dirt via detergency.		
6. Nitrogen-based fertilizer additives help keep engine valves in pristine condition.		

WHAT ARE THE PROPERTIES OF OIL?

When the word "oil" is used without particular context, it must be understood to refer to the product resulting from the refinement of crude oil – for example, motoroil, or engine oil. The properties of oil make it uniquely irreplaceable as a lubricant for vehicular and other machinery use. Oil is versatile for two reasons: it can be produced in a variety of grades, plus scores of additives have been developed, increasing its useful range of applicability. Making oil a viable product requires a large supply of the raw material, and the ability to obtain and process it at a reasonable cost. The two most important properties of oil are that it promotes freedom of movement of non-stationary parts and reduces the heat production that can cause engine seizure.

Chemically, commercial motor oil is largely a mixture of hydrocarbons – organic compounds made of hydrogen and carbon – mostly found to be straight and branched chains, though there are generally some ringed or cyclic hydrocarbons present. Crude oil composition varies somewhat according to geographic region, leading some to argue in favor of oil obtained from one area over that of another. Some, for instance, feel that crude oil originating in Pennsylvania (US) produces superior motor oil, since it has a high paraffin content but a low level of sulfur, nitrogen and asphalt.

In an internal engine, moving parts are bathed in motor oil. A film of the oil forms between these parts, effectively reducing kinetic friction and damaging heat. Not only does oil keep running machinery cool by reducing friction, but since in operation it is a relatively "thin" fluid, it carries the heat away. None of this would be of use, however, if the properties of oil did not hold up in heat – if oil was not thermally stable. As metal expands when heated, if not properly cooled, hot moving parts can be forced into complete contact, stopped and even fused together – destroying the mechanism.

Two other beneficial properties of oil include the inhibition of corrosion of metal surfaces, such as steel, and the removal of dirt and detritus via detergency. Since motor oil invariably contains some chemical "unsaturation" – carbon-to-carbon double or triple bonds – and is exposed to oxygen in the presence of considerable heat, oxidation occurs to form carboxylic acid, which attacks metal. This weakness in the natural properties of oil is effectively reduced via laboratory research performed by petroleum chemists, who develop and test new additives, which are then tested in the field using fleet vehicles. Often nitrogen-based detergent additives help keep engine valves in pristine condition.

Abridged from: https://www.wisegeek.com/what-are-the-properties-of-oil.htm

III. Read the text below and answer the questions.

1. What is a hydrocarbon?
2. What are the principal constituents of petroleum and natural gas?
3. What do the structures and chemistry of individual hydrocarbons depend on?
4. What kind of group did aromatic hydrocarbons constitute?
5. What are three main groups aliphatic hydrocarbons divided into?
6. What are their main characteristic features?

HYDROCARBONS

Hydrocarbon, any of a class of organic chemical compounds composed only of the elements carbon (C) and hydrogen (H). The carbon atoms join together to form the framework of the compound, and the hydrogen atoms attach to them in many different configurations. Hydrocarbons are the principal constituents of petroleum and natural gas. They serve as fuels and lubricants

as well as raw materials for the production of plastics, fibres, rubbers, solvents, explosives, and industrial chemicals.

Many hydrocarbons occur in nature. In addition to making up fossil fuels, they are present in trees and plants, as, for example, in the form of pigments called carotenes that occur in carrots and green leaves. More than 98 percent of natural crude rubber is a hydrocarbon polymer, a chainlike molecule consisting of many units linked together. The structures and chemistry of individual hydrocarbons depend in large part on the types of chemical bonds that link together the atoms of their constituent molecules.

Nineteenth-century chemists classified hydrocarbons as either aliphatic or aromatic on the basis of their sources and properties. Aliphatic (from Greek aleiphar, "fat") described hydrocarbons derived by chemical degradation of fats or oils. Aromatic hydrocarbons constituted a group of related substances obtained by chemical degradation of certain pleasant-smelling plant extracts. The terms aliphatic and aromatic are retained in modern terminology, but the compounds they describe are distinguished on the basis of structure rather than origin.

Aliphatic hydrocarbons are divided into three main groups according to the types of bonds they contain: alkanes, alkenes, and alkynes. Alkanes have only single bonds, alkenes contain a carbon-carbon double bond, and alkynes contain a carbon-carbon triple bond. Aromatic hydrocarbons are those that are significantly more stable than their Lewis structures would suggest; i. e., they possess "special stability." They are classified as either arenes, which contain abenzene ring as a structural unit, or nonbenzenoid aromatic hydrocarbons, which possess special stability but lack a benzene ring as a structural unit.

This classification of hydrocarbons serves as an aid in associating structural features with properties but does not require that a particular substance be assigned to a single class. Indeed, it is common for a molecule to incorporate structural units characteristic of two or more hydrocarbon families. A molecule that contains both a carbon-carbon triple bond and a benzene ring, for example, would exhibit some properties that are characteristic of alkynes and others that are characteristic of arenes.

Alkanes are described as saturated hydrocarbons, while alkenes, alkynes, and aromatic hydrocarbons are said to be unsaturated.

Abridged from: https://www.britannica.com/science/hydrocarbon

VOCABULARY AND TERMINOLOGY

IV. Read the text HYDROCARBON in detail and match the English word-combinations (1–10) with the Russian equivalents (a–j).

1)	organic chemical compound	a)	химическая связь
2)	chemical degradation	b)	органическое химическое соединение

3)	fossil fuels	c)	специфические примеси
4)	natural gas	d)	химическое разложение
5)	chemical bond	e)	образовать основу
6)	to form the framework of	f)	насыщенные углеводороды
7)	plant extract	g)	горючие полезные ископаемые
8)	raw materials	h)	природный газ
9)	saturated hydrocarbons	i)	полезные ископаемые; сырьё
10)	related substances	j)	растительный экстракт

V. For questions 1–6, choose one of the words (a–f) that best completes a gap in the text.

a)	**carbon**	**c)**	**mixture**	**e)**	**crude**
b)	**paraffins**	**d)**	**separated**	**f)**	**hydrocarbon**

Crude oil

Crude oil is a **(1)** _____ of four different types of **(2)** _____ molecule known as **(3)** _____, napthenes, aromatics, and asphaltics. The first two are five **(4)** _____ atoms or longer, aromatic has six or more, and asphaltic between forty and sixty. We can't do much with **(5)** _____ oil in its natural state, but these different molecules give us the fuels and products we need. In order to use them, they have to be **(6)** _____ from each other.
Abridged from: Naunton, J, Pohl, A. Oil and Gas 2, Oxford University Press, 2011.

VI. Fill in the gaps with the given derivatives.

mix mixture dense density related relation

1. It may also be hard to see the _____ between cause and effect.
2. Petroleum engineering is a field of engineering concerned with the activities ____ to the production of hydrocarbons, which can be either crude oil or natural gas.
3. Depleted uranium is an extremely _____ substance derived from enriched uranium
4. Oil and water don't _____. Even if you shake them together they separate into two layers.
5. Most soils are a _____ of clay, sand, and loam.
6. The strength of the absorption reveals the temperature, _____, and mass of a gas cloud.

VII. Complete the text using only one word in each sentence.

1. _____ oil and natural gas are often found together.
2. They are both made up of _____.
3. Hydrocarbons are molecules that contain only _____ and hydrogen atoms.

4. Hydrocarbons _____ a lot of energy.
5. When we _____ them, we get this energy.
6. We use hydrocarbons for _____, for heating, cooking, and transportation.
7. There are also many _____ that we can make from hydrocarbons.
8. We use _____ processes to change the hydrocarbon chains to make nylon, medicines, and lots of different plastics.

Abridged from: Naunton, J, Pohl, A. Oil and Gas 2, Oxford University Press, 2011.

VIII. Match the terms (1–10) with the definitions (a–j).

1)	crude oil	a)	is the chemical element of atomic number 6, a non-metal which has two main forms (diamond and graphite) and which also occurs in impure form in charcoal, soot, and coal.
2)	hydrocarbon	b)	is a compound of hydrogen and carbon, such as any of those which are the chief components of petroleum and natural gas.
3)	carbon	c)	a water-soluble cleansing agent which combines with impurities and dirt to make them more soluble, and differs from soap in not forming a scum with the salts in hard water.
4)	hydrogen	d)	is highly-viscous oil that cannot easily flow to production wells under normal reservoir conditions.
5)	chemical bond	e)	is a synthetic material made from a wide range of organic polymers such as polyethylene, PVC, nylon, etc., that can be moulded into shape while soft, and then set into a rigid or slightly elastic form.
6)	heavy oil	f)	is a liquid found naturally in rock, containing mostly complex hydrocarbons, with some additional organic material.
7)	plastic	g)	is a colourless, odourless, highly flammable gas, the chemical element of atomic number 1.
8)	detergent	h)	is a flammable, whitish, translucent, waxy solid consisting of a mixture of saturated hydrocarbons, obtained by distillation from petroleum or shale.
9)	mixture	i)	is a substance made by mixing other substances together.
10)	paraffin	j)	is a lasting attraction between atoms, ions or molecules that enables the formation of chemical compounds.

GRAMMAR

IX. Define the type of the conditionals.

1. If you are late again for training today, I won't let you play in tomorrow's match.
2. I wouldn't be angry if you hadn't eaten my chocolate mousse.
3. I wouldn't go out with him even if you paid me.
4. When you heat wax it melts.
5. If people used bikes instead of cars, there wouldn't be so much pollution.
6. If Sarah's alarm clock had rung, she wouldn't have missed her plane.
7. If the repairman had repaired my laptop yesterday, I could use it now.
8. If we had the access to company's network, we could have entered the data yesterday.
9. If Mary knew how to play badminton, we'd have invited her to play with us.
10. I like to visit museums if I am in a new city.

X. Make up conditional sentences based on given situations.

1. He is busy and does not come to see us. If __.
2. The girl did not study well last year and received bad marks. If __.
3. He broke his bicycle and so he did not go to the country. If __.
4. He speaks English badly: he has no practice. If __.
5. It is late, and I have to go home. If __.
6. He always gets top marks in mathematics because it is his favourite subject and he works a lot at it. If __.
7. I did not translate the article yesterday because I had no dictionary. If __.

TRANSLATION

XI. Translate the sentences into Russian.

1. Had our research been successful, we should have been able to investigate composition of Mars' atmosphere.
2. What there will be if humanity continues to destroy the natural environment?
3. Were it possible to squeeze matter together until the nuclei touch one another, then the entire earth could be compressed to the size of a football.
3. Many accidents could have been prevented, had the principles of physics been known and properly applied.
4. Should the pressure of gas be doubled, the volume would become half provided the temperature is not permitted to change.
5. If conditions had permitted, the geologists would have applied aerial prospecting.
6. Provided the geologists make use of proper prospecting methods, they will get necessary results.

7. If the geological and prospecting indications are known, it is possible, even before prospecting proper begins, to forecast not only the type of economic deposit that may be found in the given conditions but also the associated elements and the whole complex of forecasting minerals.
8. If you studied the physics of semiconductors, you would know the properties of the p-n junction.

WRITING

XII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176)

The Early Oil Industry of Poland and Romania

The Carpathian Mountains in Poland abound in oil seeps, and Carpathian oil, hand dipped from pits dug in front of the seeps, was burned in street lamps, as early as the 1500s, to provide light in the Polish town of Krosno. Unfortunately, the seep oil was a dark, viscous liquid that stuck to everything. It also burned with a foul smell and gave off more smoke and soot than other lamp oils, most of which were rendered from animal fat.

Ignacy Lukasiewicz, a Polish druggist in the modern Ukranian town of Lvov, saw the potential of using seep oil in lamps as a cheap alternative to expensive whale oil. To make a clean-burning fuel, he began experimenting with distillation techniques, perfected earlier by Dr. Abraham Gesner in Canada, to produce clear kerosene from smelly seep oil. His experiments gained notoriety, and the European oil industry was born on a dark night on July 31, 1853 when Lukasiewicz was called to a local hospital to provide light from one of his lamps for an emergency surgery. Impressed with his invention, the hospital ordered several lamps and 500 kg of kerosene. Lukasiewicz enlisted the aid of a business partner and traveled to the Vienna, capitol city of the Austro-Hungarian Empire, to register his distillation process with the government on December 31, 1853.

To provide oil for his kerosene business, Lukasiewicz initially collected a thick, sticky crude from shallow, hand-dug wells in the Gorlice region, an area in the Carpathians about 50 miles west of the Polish town of Bóbrka. The following year, he teamed up with Titus Trzecieski and Mikolaj Klobassa to establish an "oil mine" in Bóbrka which pumped crude oil from hand-drilled, 30- to 50-meter deep wells. Later, wells as deep as 150 meters were drilled that produced a lighter, better-quality crude from which to distill kero-

sene. Other entrepreneurs dug their own wells,and a thriving Polish oil industry developed, which was followed in 1857 by the drilling of wells at Bend, northeast of Bucharest, on the Romanian side of the Carpathians. Two years later, Colonel Edwin Drake, who perhaps had knowledge of the Polish developments, drilled his famous well in Pennsylvania, an event wrongly labeled by many in the industry as the drilling of the "first oil well".

Bobrka oil field, Poland in 1872

Many of these early wells were laboriously dug by hand. Others were drilled with spring poles, in which a springy wooden pole was stuck in the ground at an angle and a heavy metal drill bit attached by a cable to the head of the pole. Operators would bounce up and down on stirrups attached to the pole, causing the bit to literally chop a hole into the hard ground. The hole was cleaned by lowering into the hole a specially designed bucket, called a bailer, which was similarly bounced up and down until it filled dirt and cuttings to be hauled to the surface.

Steam engines were employed to mechanically drill wells in the Pennsylvania oil fields during the U.S. Civil War, and Thomas Bard imported a steam-powered drilling rig and crew from Pennsylvania to successfully drill a mediocre oil well in California in 1865. Steam was first used in Poland two years later in 1867 to drill a well at Kleczany, 60 kilometers west of the Bóbrka field. Steam-powered drilling made its debut at Bóbrka a few years later, sometime between 1870 and 1872, and enabled operators to drill much deeper than they had been able to previously. Within a few years virtually all oil wells, in both the United States and Europe, were being drilled mechanically.

Abridged from: http://www.sjvgeology.com/history/index.html

TEST 2

Variant 5

READING

I. Read the text and match the headings (1–4) with the paragraphs (A–D).

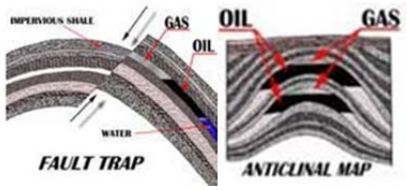
1. Stratigraphic traps ____
2. A fault trap and an anticline trap ____
3. Structural traps ____
4. Definition of a petroleum trap ____

TYPES OF PETROLEUM TRAPS

A. Petroleum trap, underground rock formation that blocks the movement of petroleum and causes it to accumulate in a reservoir that can be exploited. The oil is accompanied always by water and often by natural gas; all are confined in a porous and permeable reservoir rock, which is usually composed of sedimentary rock such as sandstones, arkoses, and fissured limestones and dolomites. The natural gas, being lightest, occupies the top of the trap and is underlain by the oil and then the water. A layer of impermeable rock, called the cap rock, prevents the upward or lateral escape of the petroleum. That part of the trap actually occupied by the oil and gas is called the petroleum reservoir.

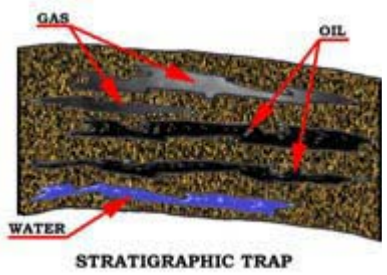
B. Geologists have classified petroleum traps into two basic types: structural traps and stratigraphic traps. Structural traps are traps that are formed because of a deformation in the rock layer that contains the hydrocarbons. Two common examples of structural traps are fault traps and anticlines.

C. A fault trap occurs when the formations on either side of the fault have been moved into a position that prevents further migration of petroleum. For example, an impermeable formation on one side of the fault may have moved opposite the petroleum-bearing formation on the other side of the fault. Further migration of petroleum is prevented by the impermeable layer. An anticline is an upward fold in the layers of rock, much like an arch in a building. Petroleum migrates into the highest part of the fold, and its escape is prevented by an overlying bed of impermeable rock.



D These are traps that result when the reservoir bed is sealed by other beds or by a change in porosity or permeability within the reservoir bed itself.

There are many different kinds of stratigraphic traps. In one type, a tilted or inclined layer of petroleum-bearing rock is cutoff or truncated by an essentially horizontal, impermeable rock layer. Or sometimes a petroleum-bearing formation pinches out; that is, the formation is gradually cut off by an overlying layer. Another stratigraphic trap occurs when a porous and permeable reservoir bed is surrounded by impermeable rock. Still another type occurs when there is a change in porosity and permeability in the reservoir itself. The upper reaches of the reservoir may be impermeable and nonporous, while the lower part is permeable and porous and contains hydrocarbons.



STRATIGRAPHIC TRAP

Abridged from: http://www.usoilandgas.net/findingoil.htm; https://www.britannica.com/science/petroleum-trap

II. Read the text about the uses of geophysics. Write whether the following statements are true (T) or false (F).

Statement	True/False (T/F)	
1. Nowadays people noted that some heavier, shining rocks could be heated.		
2. It is beyond the scope of any one person's mind to contain all of the knowledge of mineral exploration.		
3. Usually the methods of geophysics are used when soil materials conceal the presence of subsurface mineral deposits.		
4. Instruments used for geophysical surveying are the end product of considerable research on geophysical conditions and field needs.		
5. Using a single geophysical method alone is much more helpful in understanding a subsurface exploration situation.		

THE USES OF GEOPHYSICS

In ancient times men noted that some heavier, shining rocks could be heated and processed to extract useful metals. Ore rocks were sought by visual surface methods and eventually the science of geology became developed to explain the presence and origin of these useful materials. The geologist's tasks have finally become so numerous that it is beyond the scope of any one person's mind to contain all the knowledge and skills of the field of mineral exploration. Geophysical exploration is necessary in the search for minerals.

The methods of geophysics are most often called upon when soil or other earth covering materials conceal the presence of possible subsurface mineral deposits. Then we rely upon the contrasts in physical properties of these sought-for minerals, or any associated properties of the deposit environment, to assist in the exploration procedure. The methods of geophysical exploration do not rely on the visual properties of mineral color but rather on the unseen contrasts in density, magnetism, acoustic behavior, electrical conductivity, or radioactivity of earth materials.

Instruments used for geophysical surveying usually are specially-engineered, self-powered devices designed to operate under a wide variety of environmental conditions. They are the end product of considerable research of geophysical conditions, field needs, and advanced methods of instrumentation. They utilize miniaturized electronics, often together with mechanical and optical devices in order to achieve their purposes. The interpretation of geophysical exploration field results depends on geological reasonableness as one of the necessary interpretative conditions. A combination of geophysical methods when used together with geological and geochemical information is much more helpful in understanding a subsurface exploration situation than using a single geophysical method alone.

Abridged from: English. Correspondence Course. Student's book, TPUPublishing House, 2014.

III. Read the text below and answer the questions.

1. What is the object of geophysical survey?
2. Why is structural information essential in oil prospecting?
3. Why are both structural and physical properties of mineral bodies important for the exploration?
4. Which rock properties are essential for geophysical prospecting?
5. What is the common feature of seismic and electrical methods?

OBJECTS OF GEOPHYSICAL SURVEYS

The objects of geophysical survey are to locate subsurface geological structures or bodies and where possible to measure their dimensions and relevant physical properties. In oil prospecting structural information is sought because of the association of oil with particular features such as anticlines in sedimentary rocks. In mining geophysics the emphasis is on detection and determination of physical properties. Though mineral ore bodies give distinctive and measurable geophysical indications they are often of irregular shape and occur in rocks of complex structure, making precise quantitative interpretation difficult or impossible. In site investigation engineers may be interested in both structure and physical properties. Variations in bedrock depth are often needed on major construction sites and the mechanical properties of the overburden may be important when heavy loads have to be sustained.

A geophysical survey consists of a set of measurements, usually collected to a systematic pattern over the earth's surface by land, sea or air, or vertically in a borehole. In choosing the geophysical technique to be used to study a problem the contrasting properties of the subsurface rocks and their homogeneity within a particular formation are important factors to be considered.

The properties of rocks of which most use is made in geophysical prospecting are elasticity, electrical conductivity, density, magnetic susceptibility and remanence and electrical polarizability. To a lesser extent other properties such as degree of radioactivity are also utilized.

Gravitational and magnetic surveys make use of natural fields of force. Most seismic and electrical (including electromagnetic) methods, which involve the elastic and electrical properties of rocks, necessitate introducing energy into ground. Since the source is under control the source to detector distance can be varied. This makes it possible when gravity and magnetic fields are being utilized.

Many factors – geological, economic, logistic and what we might call geophysical govern the choice of method for particular survey. In many instances more than one method will be used to survey the same ground. The search for oil may start with gravity and airborne magnetic work as a preliminary to seismic shooting in localities determined by interpretation of the earlier surveys. Combining electromagnetic, magnetic and gravity data may make it possible to decide whether certain indications are of valuable metallic ores or merely of concentrations of uneconomic minerals.

Remote sensing aircraft

The final decision to be taken in prospecting and site investigation is whether or when to drill. In civil engineering where depths of investigation are small and high accuracy is required it may pay to dispense with geophysics and drill from the outset. As depths or distances to be covered increase, particularly if the geology is simple, geophysics will be increasingly used. In prospecting for oil the structures to be discovered lie at great depth, making exploratory drilling on a large scale prior geophysical survey out of question.
Abridged from D.H. Griffiths, R.F. King Applied Geophysics for Geologists and Engineers. The Elements of Geophysical Prospecting. Oxford, 1981

VOCABULARY AND TERMINOLOGY

IV. Read the text OBJECTS OF GEOPHYSICAL SURVEYS in detail and match the English word-combinations (1–10) with the Russian equivalents (a–j).

1)	geophysical survey	a)	количественная интерпретация
2)	emphasis is on	b)	разведочное / колонковое бурение
3)	oil prospecting	c)	дистанционные измерения
4)	quantitative interpretation	d)	электроразведка
5)	electrical conductivity	e)	электропроводимость
6)	magnetic susceptibility	f)	акцент делается на ч.-л., особое внимание уделяется ч.-л
7)	electric survey	g)	геофизическая разведка
8)	seismic survey	h)	магнитная восприимчивость
9)	exploratory drilling	i)	сейсмические исследования
10)	remote sensing	j)	нефтеразведка

V. For questions 1–6, choose one of the words (a–f) that best completes a gap in the text.

a) economic	**c) quantitative**	**e) radioactivity**
b) general	**d) geophysics**	**f) earth**

Geophysics, a branch of **(1)** _____ sciences, is the non-invasive study of the Earth by **(2)** _____ physical methods, especially by seismic, electromagnetic, and **(3)** _____ methods. The theories and techniques of geophysics are employed extensively in the planetary sciences in **(4)** _____.
Exploration **(5)** _____ is the use of seismic, gravity, magnetic, electrical, electromagnetic, etc., methods in the search for oil, gas, minerals, water, etc., with the objective of **(6)** _____ exploitation.

VI. Fill in the gaps with the given derivatives.

surveyor survey surveyed surveying prospecting prospector

1. A gold _____ is a person who explores or prospects an area in search of mineral deposits, such as gold.
2. A geological _____ is the systematic investigation of the geology beneath a given piece of ground for the purpose of creating a geological map or model.
3. Over the years since then, we have spent billions mapping, measuring and _____ Antarctica from land, sea and space.
4. Some adjacent areas were also _____, although less intensively.
5. _____ is the physical search for minerals, fossils, precious metals or mineral specimens, and is also known as fossicking.
6. _____s determine the position of objects by measuring angles and distances.

VII. Complete sentences using one word only.

1. Exploration geophysics represents the use of seismic, gravity, magnetic methods in _____ for oil, gas with the objective of economic exploitation.
2. Structural traps are traps that are formed because of a deformation in the rock layer that contains the _____.
3. _____ exploration methods are used to accumulate the geophysical data that can further be brought into use to prospect economic minerals.
4. A fault trap occurs when the formations on either side of the fault have been moved into a position that prevents further _____ of petroleum.
5. The knowledge of geologic conditions is _____ in some industrial fields.
6. A remote sensing _____ is a software application that processes remote sensing data.
7. _____ survey technique is based on determining the time interval that elapses between the initiation of a seismic wave at a selected shot point (the location where an explosion generates seismic waves) and the arrival of reflected or refracted impulses at one or more seismic detectors.
8. Elasticity, electrical conductivity, density, magnetic susceptibility and remanence and electrical polarizability are _____ of rocks.
9. Two common examples of _____ traps are fault traps and anticlines.
10. A seismic _____ is a vibration generated by an earthquake, explosion, or similar energetic source and propagated within the Earth or along its surface.

VIII. Match the terms (1–10) with the definitions (a–j).

1)	Stratigraphic traps	a)	is the search by petroleum geologists and geophysicists for hydrocarbon deposits beneath the Earth's surface, such as oil.
2)	A fault trap	b)	are formed as a result of lateral and vertical variations in the thickness, texture, porosity or lithology of the reservoir rock.
3)	An anticline trap	c)	is a method used by geologists in archaeological geophysics. Through Magnetic Survey, geologists can analyze the Earth's magnetic field and the spatial variation in it.
4)	Structural traps	d)	are formed as a result of changes in the structure of the subsurface, due to tectonic, diapiric, gravitational and compactional processes
5)	Seismic survey	e)	is a structural trap which is closed by an anticline.
6)	Oil exploration	f)	is a hydrocarbon trap in which closure is caused by a geological fault.

7)	Remote sensing	g)	is the systematic collection of geophysical data for spatial studies. Detection and analysis of the geophysical signals forms the core of Geophysical signal processing.
8)	Geophysical survey	h)	is any interpretive technique that produces results that are numerically related to earth properties or behaviour.
9)	Magnetic survey	i)	is the science of obtaining information about something such as an object or a process without direct physical contact; information obtained through remote sensory techniques.
10)	Quantitative interpretation	j)	is a method of investigating underground properties and rock patterns using induced shock wave reflections.

GRAMMAR

IX. Put the verbs in the correct form to form the conditionals.

1. When my sister __ (to come) to town we __ (to go) to the cinema together.
2. If I __ (to have) free time now I __ (to watch) my favourite film.
3. If you __ (not to smoke) so much you __ (to not be) in hospital now.
4. If my kids __ (to run) in the playground they __ (to become) very thirsty.
5. She __ (to be) angry if you __ (to lose) this photo.
6. If I __ (to be) you I __ (not to eat) fast food.
7. His job __ (be) so hard if he __ (not to have) a secretary.
8. If it __ (to cost) too much I __ (not to take) it.
9. If we __ (to meet) him yesterday we __ (to call) you.
10. If you __ (not to eat up) the bread we __ (to feed) the birds in the garden.

X. Make up conditional sentences. The situations are given. Mind mixed conditionals.

1. She could not mend her dress herself because she had no needle. If __.
2. He is not a first-class sportsman now because he did not train enough last year. If __.
3. The pupils were active because they wanted to understand this difficult material. If __.
4. The pupils did not understand the homework because they were inattentive. If __.
5. The pupils worked hard and did well in their exams. If __.
6. She won't try to enter the foreign languages department because she is not good at foreign languages. If __.

TRANSLATION

XI. Translate the sentences into Russian.

1. If it were possible to penetrate the atmosphere of Venus, we should be able to solve the problem if life does or doesn't exist there.
2. There will be no progress except into poverty and deprivation if humanity continues to destroy the natural environment.
3. The productive capacity of the natural environment is such that, if properly protected and managed, it can yield an abundant interest, and – in theory at least – humanity can live very comfortably on that interest.
4. What there will be if humanity continues to destroy the natural environment?
5. If the forests had remained to absorb the downpour, floods would not have threatened the valley's residents.
6. If we recycle things, we can save money, energy and natural resources.
7. If we stop using natural resources, we can save money, energy.
8. They thought that if they could find the right formula, they could, for example, add a certain amount of mercury to lead and produce gold.

WRITING

XII. Write an abstract (100–120 words) to the following article. (For more details you may see Writing Reference p. 176).

TREATMENT OF CRUDE OIL

Crude oil is a mixture of comparatively volatile liquid hydrocarbons (compounds composed mainly of hydrogen and carbon), though it also contains some nitrogen, sulfur, and oxygen. Those elements form a large variety of complex molecular structures, some of which cannot be readily identified. Regardless of variations, however, almost all crude oil ranges from 82 to 87 percent carbon by weight and 12 to 15 percent hydrogen by weight.

Crude oils are customarily characterized by the type of hydrocarbon compound that is most prevalent in them: paraffins, naphthenes, and aromatics. Paraffins are the most common hydrocarbons in crude oil; certain liquid paraffins are the major constituents of gasoline (petrol) and are therefore highly valued. Naphthenes are an important part of all liquid refinery products, but they also form some of the heavy asphaltlike residues of refinery processes. Aromatics generally constitute only a small percentage of most crudes. The most common aromatic in crude oil is benzene, a popular building block in the petrochemical industry.

Because crude oil is a mixture of such widely varying constituents and proportions, its physical properties also vary widely. In appearance, for instance, it ranges from colourless to black. Possibly the most important physi-

cal property is specific gravity (i. e., the ratio of the weight of equal volumes of a crude oil and pure water at standard conditions).

Crude oil also is categorized as "sweet" or "sour" depending on the level of sulfur, which occurs either as elemental sulfur or in compounds such as hydrogen sulfide. Sweet crudes have sulfur contents of 0.5 percent or less by weight, and sour crudes have sulfur contents of 1 percent or more by weight. Generally, the heavier the crude oil, the greater its sulfur content. Excess sulfur is removed from crude oil during refining, because sulfur oxides released into the atmosphere during combustion of oil are a major pollutant.

Crude oil occurs underground, at various pressures depending on depth. It can contain considerable natural gas, kept in solution by the pressure. In addition, water often flows into an oil well along with liquid crude and gas. All these fluids are collected by surface equipment for separation. Clean crude oil is sent to storage at near atmospheric pressure, usually aboveground in cylindrical steel tanks that may be as large as 30 metres (100 feet) in diameter and 10 metres (33 feet) tall. Often crude oil must be transported from widely distributed production sites to treatment plants and refineries. Overland movement is largely through pipelines. Crude from more isolated wells is collected in tank trucks and taken to pipeline terminals; there is also some transport in specially constructed railroad cars. Overseas transport is conducted in specially designed tanker ships. Tanker capacities vary from less than 100,000 barrels to more than 3,000,000 barrels.

The primary destination of crude oil is a refinery. There any combination of three basic functions is carried out: (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. The main process for separating the hydrocarbon components of crude oil is fractional distillation. Crude oil fractions separated by distillation are passed on for subsequent processing into numerous products, ranging from gasoline and diesel fuel to heating oil to asphalt. Given the pattern of modern demand (which tends to be highest for transportation fuels such as gasoline), the market value of a crude oil generally rises with increasing yields of light products.

Abridged from: https://www.britannica.com/science/crude-oil

VOCABULARY REFERENCE

Appendix 1

Unit 1–2 (Self-Study, TEST 1)

applied geology – прикладная геология
apply – применять
approach – подход
be closely linked to – быть тесно связанным с
be concerned with – иметь дело (заниматься) с
be responsible for – отвечать за
branch – отрасль, раздел (науки)
cleavage – спайность, отслоение
collaborate – сотрудничать
composition – состав
conditions – условия
crust – кора
decrease – понижаться
deposit – залежь, месторождение
design – проектировать
determine – определять, устанавливать
develop – разрабатывать, развивать
development – разработка, развитие
dissolve – расствориться
distribution – распределение
earthquake – землетрясение
endogenous – эндогенный
engineering – технология, техника; инженерно-техническая деятельность, инженерно-технические работы
erosion – эрозия
exogenous – экзогенный
expand – расширяться
experience – опыт
exploitation – эксплуатация, разработка месторождения
extract oil – добывать нефть
fill in – заполнить
folding – складчатость
forecast – прогнозировать
fracture – трещина разлома
geological maps – геологические карты
geological tools – геологические инструменты
geoscience – науки о земле

hardness – твердость
hydrothermal rocks – гидротермальные породы
igneous rocks – вулканичесике породы
improvement – улучшения, усовершенствования
inject – нагнетать, закачивать
install – устанавливать
introduce – вводить, представлять
involve – включать
layer – слой
lithificaion – окаменение
measure – мерить; мера
metamorphic rocks – метаморфические породы
mineral – минерал
mining engineering – горная техника, горное дело
occur – случаться, сущестовать
opportunity – возможность
paleontology – палеонтология
permeability – проницаемость
porosity – пористость
porous rock – пористая порода
process – обрабатывать
produce – добывать
production – добыча
properties – свойства
provide – предоставлять
raw (products) – сырье
require – требовать
resistance – сопротивление
responsibility – обязанность
sedimentary rocks – осадочные породы
select – отбирать
selection – отбор
site – участок, место выполнения работ, “поле”
steam – пар
substance – вещество, материя
surface – поверхность
take samples – брать образцы
technique – техника (методика), метод; оборудование
tansparency – прозрачность
viscosity – вязкость
volcanic activity – вулканическая активность
weathering – выветривание

VOCABULARY REFERENCE

Unit 3–4 (Self-Study, TEST 2)

abundance – распространённость
access – доступ
accumulate (v) – накапливать; накоплять
adjacent (to) – смежный, прилегающий
aerial – воздушный, наземный
affect – воздействовать (на что-л.); влиять;
alter (v) – изменить
apex – вершина
barren – непродуктивный;пустой (*о породе*)
cap rock – покрывающая порода, покрышка залежи
capital investment – капиталовложения
certain – определенный; некоторый;
certainly – конечно
chute – скат, спуск; углеспускная выработка; жёлоб
compaction – уплотнение
to compare – (with) сравнивать, проводить параллель
to contribute – способствовать, содействовать; делать вклад (*в науку*); make a (one's) ~ to smth. сделать вклад во что-л.
cook (v) – подвергаться тепловой обработке
cost – стоить; цена; стоимость
country rock – коренная (основная) порода
crop – out) обнажать(ся), выходить на поверхность (о пласте, породе)
cross-section – поперечное сечение, поперечный разрез, профиль
crude oil – сырая нефть
decay – сгнивший
decompose – decomposition – разлагаться – разложение
depression – впадина
distinctive properties – отличительные свойства
to develop – разрабатывать (*месторождение*); развивать (*добычу*); производить подготовительные работы;
development – подготовительные работы; развитие добычи; развитие
development work – техническая/ технологическая разработка
dredging – выемка грунта; драгирование

drill – бурить, сверлить; бурение, сверление; бурильный молоток
drilling – бурение, сверление; core-drilling колонковое (керновое) бурение
drive – проходить (горизонтальную выработку); приводить в движение; управлять (машиной); горизонтальная выработка; привод; передача
drift – штрек, горизонтальная выработка
to ensure – обеспечивать, гарантировать
evidence – снование; признак(и); свидетельства
exert (v) – оказывать давление
expansion – распространение (на большую площадь)
to expect – ожидать; рассчитывать; думать; предлагать
to explore – разведывать месторождение полезного ископаемого с попутной добычей
exploratory – разведочный
exploration – детальная разведка; разведочные горные работы по месторождению
face – забой; лава
feedstock – исходный сырое
fine-grained – мелкозернистый
floor – почва горной выработки, почва пласта (жилы);
fold – складка
fracture – разлом, трещина
galena – галенит, свинцовый блеск
to govern – править, управлять; руководить; определять, обусловливать
hydrocarbons – углеводороды
inclination – уклон, скат, наклон *(пластов);* наклонение;
incline – уклон, бремсберг, скат; наклонный ствол; gravity ~ бремсберг
inclined – наклонный; flatly ~ слабо наклонный; gently ~ наклонного падения; median ~ умеренно наклонный (*о пластах*); steeply ~ крутопадающий
to indicate – указывать, показывать; служить признаком; означать
interweave (v) – перемешивать, вкраплять
kerogen – кероген
lead – свинец
lens – чечевицеобразная залежь, линза
level – этаж, горизонт, горизонтальная горная выработка; штольня; уровень *(инструмент);* нивелир; ватерпас; горизонтальная поверхность

limestone – известняк
to look for – искать
malleable metal – ковкий металл
metallic mineral – полезные рудные ископаемые
mineral-bearing – содержащий минерал
mixture – смесь
mode of occurrence – условия залегания
mudstone – аргиллит
nitrogen – азот
non-metallic mineral – полезные нерудные ископаемые
to open up – вскрывать (месторождение); нарезать (новую лаву, забой)
opening – горная выработка; подготовительная выработка; вскрытие месторождения
ore extraction – добыча руды
oxygen – кислород
panning – промывка (золотоносного песка в лотке)
permeable (impermeable) – проницаемый
permeability – проницаемость
pocket – карман
porous – пористый
porosity – пористость
preserve (v) – сохранять
processing – обработка
processing industry – обрабатывающая промышленность
production work – выработка; производительность
property – свойство
to prove – разведывать (характер месторождения или залегания); доказывать; испытывать, пробовать
proved – разведанный, достоверный
proving – опробование, предварительная разведка
quarry – подошва карьера; пол, настил
to recover – извлекать (*целики*); выбирать, очищать; добывать (*уголь и т. п.*); восстанавливать
recover oil – добывать нефть
to remove – удалять; убирать; устранять; перемещать
removal – вскрыша; выемка;уборка (*породы*); извлечение (*крепи*); перемещение

reservoir rock – порода – коллектор
refining – очистка, перегонка (нефти)
residue – остаток
rib – ребро; выступ; узкий целик, предохранительный целик; грудь забоя
roof – крыша; кровля выработки; кровля пласта (*или* жилы); перекрытие; ~ support крепление кровли
sandstone – песчаник
seam – ~ падение (*пласта*); наклон (*пласта*)
to search – исследовать; (for) искать (месторождение); поиск; syn prospecting
separation – разделение, разложение на части
shaft – шахтный ствол; auxiliary ~ вспомогательный ствол; hoisting ~ подъемный ствол; главный шахтный ствол
shale – сланец
sign – знак, символ; признак, примета
sink (v) – погружаться
source rock – материнская порода
split up (v) – разделять
to store – хранить, накапливать (о запасах)
sulfur – сера
tabular – пластовый (о *месторождении);* пластообразный; плоский; линзообразный
tarry – смолистый
trap – ловушка
unconformity – несогласное напластование
viscous – густой, вязкий
volatile – летучий, быстро испаряющийся
waste – пустая порода; отходы
well – буровая скважина; колодец, источник; водоем; зумф
to work – работать; вынимать, извлекать (уголь, руду); вырабатывать
working – разработка, горная выработка
workable – подходящий для работы, пригодный для разработки, рабочий (о пласте); рентабельный

Appendix 2

GRAMMAR REFERENCE

Units 1–2

ПАССИВНЫЙ ЗАЛОГ

В английском языке существуют две формы залога:

Активный залог: *I wrote the article last Monday.* – Я написал статью в прошлый понедельник.

Пассивный залог: *The article was written last Monday.* – Статья была написана в прошлый понедельник.

Пассивный залог (или страдательный залог) широко употребляется в современном английском языке, как в устной, так и письменной речи. Обычно пассивные конструкции используются, если нет необходимости называть исполнителя действия, который подразумевается из контекста, или же, если не имеет значения, кто выполняет действие, а важен лишь результат этого действия.

Пассивный залог в английском языке употребляется, как правило, с переходными глаголами, то есть с глаголами, которые имеют после себя дополнение.

Форма пассивного залога образуется с помощью глагола *to be* в нужной форме (в зависимости от времени) и формы причастия прошедшего времени смыслового глагола:

to be + Past participle

Если глагол правильный, то его форма образуется путем присоединения окончания *-ed* к основе глагола: *open – opened*. Форму неправильных глаголов можно найти в таблице неправильных глаголов в 3 колонке.

В пассивном залоге насчитывается 10 временных форм. Времена *Future Continuous, Future Continuous in the Past* и все формы *Perfect Continuous* в пассивном залоге не употребляются.

Отрицательные и вопросительные формы глагола в пассивном залоге

Отрицательная форма глагола в пассивном залоге образуется с помощью частицы *not*, которая следует за вспомогательным глаголом (если вспомогательных глаголов несколько, то *not* ставится после первого):

*The article **was** not written last Monday.* – Статья не была написана в прошлый понедельник.

*I **am** not often invited to the cinema.* – Меня не часто приглашают в кино.

Для образования вопросительного предложения в пассивном залоге первый вспомогательный глагол ставится перед подлежащим:

Have the rules of the game been explained to you? – Вам объяснили правила игры?

Are you often invited to the cinema? – Тебя часто приглашают в кино?

	Present	**Past**	**Future**
Simple (to be + Part II)	am (is, are) + Part II	was (were) + Part II	shall (will) be + Part II
	The letters are written every day. **Отр. ф.** *The letters are not written every day.* **Вопр. ф.** *Are the letters written ...? Yes, they are. No, they are not*	*The letters were written yesterday.* **Отр. ф.** *The letters were not written yesterdav* **Вопр. ф.** *Were the letters written yesterdav? Yes, they were. No, they were not*	*The letters will be written tomorrow.* ***Отр. ф.*** *The letters will not be written tomorrow.* ***Вопр. ф.*** *Will the letters be written tomorrow? Yes, they will. No, they won't*
Continuous (to be being + Part II)	am (is, are) being + Part II	was, (were) being + Part II	–
	The letter is being written now. **Отр. ф.** *The letter is not being written now.* **Вопр. ф.** *Is the letter being written now?*	*The letter was being written from 5 to 6.* **Отр. ф.** *The letter was not being written from 5 to 6.* ***Вопр. ф.*** *Was the letter being written from 5 to 6?*	
Perfect (to have been + Part II (ed, 3 ф.)	have (has) been + Part II	had been + Part II	shall (will) have been + Part II
	The letters have been written today. **Отр. ф.** *The letters have not been written today.* **Вопр. ф.** *Have the letters been written today?*	*The letters had been written by 3 o'clock yesterday.* **Отр. ф.** *The letters had not been written.* ***Вопр. ф.*** *Had the letters been written?*	*The letters will have been written by 3 o'clock tomorrow.* **Отр. ф.** *The letters will not have been written by tomorrow.* **Вопр. ф**. *Will the letters have been written by Sunday?*

Употребление предлогов *by*, *with* в пассивном залоге

Предлоги *by* и *with* употребляются при необходимости упоминания лица или предмета, осуществляющего действие, а также предмета, являющегося инструментом действия или материалом, с помощью которого действие производится

Предлог *by* используется, чтобы сказать, что или кто выполнил действие:

The cake was cooked by my Granny. – Пирог испечён моей бабушкой.

Предлог *with* употребляется для того, чтобы рассказать какой инструмент или материал был использован.

The bread was cut with a knife. – Хлеб порезали ножом.

В пассивном залоге можно и не употреблять предлоги *by* и with, так как упоминание действующего лица и тем более материала или инструмента необязательно.

Однако в вопросительных конструкциях в пассивном залоге, начинающихся с *who* (кем?) и иногда с *what* (чем?) всегда присутствует предлог *by*.

Who was the Mona Lisa painted by? – Кем была написана Мона Лиза?

What was the flood caused by? – Чем было вызвано наводнение.

Пассивный залог. Двойные конструкции

Некоторые переходные глаголы в английском языке могут иметь два дополнения (прямое и косвенное):

to give a book – дать (что?) книгу (прямое дополнение);

to give smbd – дать (кому?) кому-либо(косвенное дополнение).

К таким глаголам относятся:

to give(давать), to ask (спрашивать), offer (предлагать), to teach (обучать), to tell (рассказывать), to lend (одалживать), to promise (обещать), to sell (продавать), to throw (бросать), to show (показывать), to pay (платить), to send (отправлять), to allow (позволять), to answer (отвечать), to forgive (прощать), to invite (приглашать), to advise (советовать).

Такие глаголы образуют двойные конструкции и в активном, и в пассивном залоге:

Активный залог: *He gave me the book. / He gave the book to me.* – Он дал мне книгу.

Пассивный залог: *I was given the book (by him). / The book was given to me (by him).* – Мне дали книгу.

Такие глаголы как to explain smth to smbd (объяснять что-то кому-то), to point out (указывать), to announce (объявлять), to dictate (диктовать), to describe (описывать), to mention (упоминать), to repeat (повто-

рять), to suggest (предлагать), to propose (предлагать) образуют только одну конструкцию в пассивном залоге:

A new plan was suggested to us. – Нам предложили новый план (план был предложен).

The rule was explained to him. – Ему объяснили правило (правило было объяснено).

Глаголы с предлогом в пассивном залоге

Очень много глаголов в английском языке употребляются с дополнением, имеющим предлог. В этом случае в пассивном залоге предлог ставится сразу после глагола:

The doctor was sent for. – За доктором послали.

The lecturer was listened to with great attention. – Лектора слушали с большим вниманием.

The weather is often spoken about. – О погоде часто говорят.

Why is he always laughed at? – Почему над ним всегда смеются?

Сравните:

The doctor was sent. – Доктора послали.

The doctor was sent for. – За доктором послали.

Глаголы, не употребляющиеся в пассивном залоге

Глаголы, которые обозначают не действие или процесс, а состояние лица или предмета, не употребляются в пассивном залоге:

to have (иметь), to resemble (быть похожим), to become (становиться), to fit (соответствовать), to suit (подходить), to lack (недоставать) и другие.

Данные ниже предложения употреблены в активном залоге, употребить пассивный залог в этом случае невозможно.

I resemble my mum. – Я похожа на свою маму.

He has become a doctor. – Он стал доктором.

GRAMMAR REFERENCE

Units 3–4

CONDITIONALS

Условные предложения или придаточные предложения условия (**Conditionals**) – это сложноподчинённые предложения, состоящие из главного предложения (**Main clause**) и придаточного условия (**if-clause**), которое часто вводится союзом *if*. Условные предложения в английском языке используются для описания осуществимых или неосуществимых ситуаций и бывают четырех типов.

Zero Conditionals (general truth) – условные предложения данного типа всегда являются 100 % истиной, они часто описывают законы природы, общеизвестные истины/факты.

If-clause	Main clause	Вероятность совершения действия
Present Indefinite	Present Indefinite	100 %
If temperature is zero,	*water freezes*	Если температура равна нулю, вода замерзает
If you heat water,	*it boils*	Если вы нагреете воду, она закипит

В предложениях этого типа возможна смысловая замена союза *if* (если) на *when* (когда):

***When** you have a weak signal, your phone works harder, giving off more radiation.* – Когда сигнал слабый, ваш телефон работает интенсивнее, с большим излучением.

First Conditionals (real possibility) – условные предложения I типа выражают реальные, возможные ситуации в настоящем или будущем. Вероятность, что действие произойдет, очень велика.

If-clause	Main clause	Вероятность совершения действия
Present Simple	Future Simple + +infinitive without to	50–75 %
If it rains,	*I will not go to the park.*	Если пойдет дождь, я не пойду в парк. (я не знаю, пойдет дождь или не пойдет)
If I see Mary,	*I will tell her.*	Если я увижу Мери, я скажу ей. (я могу ее увидеть, а могу и не увидеть)

Second Conditionals (imagine situations) – условные предложения II типа выражают действия, совершение которых в определенных ситуациях в настоящем и будущем оказывается нереальным. Вероятность, что действие произойдет, равна нулю.

If-clause	Main clause	Вероятность совершения действия
Past Simple	would + infinitive without to	0 %
If I had a lot of money,	*I would travel round the world.*	Если бы у меня было много денег, я бы путешествовал по всему свету. (но у меня нет таких денег)
If I were you,	*I would drive more carefully in the rain.*	Если бы я был на твоем месте, я бы вел машину аккуратнее во время дождя. (но я не на твоем месте)

После союза *if* если, форма глагола *to be* – ***were*** может использоваться вместо формы ***was*** для всех лиц.

If I was/were you, I would try harder. – Если бы я был тобой, я бы старался усерднее.

Third Conditionals (lost chances) – условные предложения III типа выражают воображаемые ситуации, относящиеся к прошлому. Вероятность, что действие произойдет, равна нулю.

If-clause	Main clause	Вероятность совершения действия
Past Perfect	would (could, should, might) have + + past participle	0 %
If I had gone to Egypt,	*I could have learned Arabic.*	Если бы я поехал в Египет, я бы мог выучить арабский язык. (но я не поехал, и поэтому я не выучил)
If the weather had been nice 2 days ago,	*I would have gone to the beach.*	Если бы погода была хорошей 2 дня назад, я бы пошел на пляж. (но погода была плохая, и я не пошел на пляж)

Mixed Conditionals – условные предложения смешанного типа в английском языке бывают двух типов, чаще всего для образования смешанных условных предложений используются условные предложения II и III типа.

1. Смешение II и III типа условных предложений. В этом случае придаточное предложение относится к настоящему времени, а главное предложение относится к прошлому и описывает ситуацию, которая уже произошла.

If I were (II) *smarter, I would have graduated* (III) *from Stanford.* – Если бы я был сообразительнее, я бы закончил Стэнфорд.

2. Смешение III и II типа условных предложений. В этом случае придаточное предложение относится к прошлому времени, а главное предложение к настоящему.

If my father hadn't lost (III) *his keys, we wouldn't have to* (II) *wait until he finds them.* – Если бы мой отец не потерял ключи, нам не пришлось бы ждать, пока он найдет их.

Союзы в условных предложениях

В условных предложениях чаще всего используется союз *if* если. Но также встречаются:

in case (that) – в случае, если

provided/ providing (that) – при условии, если/ при условии, что

unless/ if not – если не

suppose/ supposing (that) – если бы, в случае.

In case (that), provided/ providing (that) встречаются в основном в предложениях с реальным условием:

In case *I don't find her at home, I'll leave her a note.* – В случае, если я не застану ее дома, я оставлю ей записку.

We'll finish the work on time ***provided*** *you send all the necessary materials.* – Мы закончим работу вовремя, при условии, что вы пришлёте все необходимые материалы.

Unless имеет отрицательное значение и используется в предложениях с реальным условием:

I'll come in time ***unless*** *I am detained at work.* – Я приду вовремя, если меня не задержат на работе.

Suppose/ supposing (that) более характерен для предложений с нереальным условием:

Suppose *she wrote to you, what would you answer?* – Предположим, она вам напишет, что бы вы ответили?

Инверсия в условных предложениях

В уловных предложениях II и III типа может быть опущен союз. В этих случаях в придаточных предложениях наблюдается инверсия, т. е. обратный порядок слов. Формы глаголов *to be, to have, should, could* становятся перед подлежащим.

Had *I time, I* ***should make*** *this experiment.* – Было бы у меня время, я бы провёл эксперимент.

Were *I free, I* ***should*** *ski.* – Был бы я свободен, я бы покатался на лыжах.

Особенности английской пунктуации

Если придаточное предложение (условия) стоит перед главным, то между ними ставится запятая, если же главное предложение предшествует придаточному предложению, то запятую ставить не нужно.

WRITING REFERENCE

Writing Abstract

Appendix 3

Аннотация (Abstract)

Рекомендации по написанию аннотации английского текста

Рекомендуемый объем аннотации – 100–120 слов. Аннотация к тексту включает только самые основные положения и выводы, которые даются в сжатой форме. Аннотация выполняет следующие функции: – позволяет определить основное содержание текста (или статьи), его релевантность и решить, следует ли обращаться к полному тексту; – предоставляет информацию о тексте (статье) и устраняет необходимость чтения его полного текста в случае, если он представляет для читателя второстепенный интерес; В аннотации не должны повторяться предложения из текста (нельзя брать предложения из текста и переносить их в аннотацию), а также ее название.

В аннотации должны излагаться существенные факты, приведенные в тексте, и не должен содержаться материал, который отсутствует в самом тексте. В тексте аннотации следует избегать слишком длинных предложений, а также сложных грамматических конструкций. Текст должен быть лаконичен и четок.

Аннотация (abstract) состоит из:

1. Вводная часть – главная идея текста и основная информация (Кто? Что? Где? Когда?).
2. Основная часть – перечень затронутых в тексте проблем.
3. Заключительная часть, в которой пишущий высказывает свое мнение.

При написании аннотации следует использовать клишированные вводные слова.

Вводная часть:

The text deals with …
As the title implies the text describes …
The text is concerned with…

Основная часть:

It is known that …
It should be noted about/that …
It is spoken in detail about…
It is reported that …
The text gives valuable information on/about…
Much attention is given to…

It is shown that…
The main idea of the text is…
It gives a detailed analysis of…
It draws our attention to…
It is stressed that…

Заключение

Оценка:

The following conclusions are drawn…
The text gives valuable information about…

Рекомендация:

The main idea of the text is …
The text is of great help to …
The text is of interest to …

Можно следовать следующей краткой схеме:

1. The text tells about _____.
2. The author points out _____.
3. He believes _____.
4. In the second part of the text he continues _____.
5. The author also gives the information about _____.
6. In conclusion _____.

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Составители

ШВАГРУКОВА Екатерина Васильевна
ПОЗДЕЕВА Галина Петровна
КОЛБЫШЕВА Юлия Владимировна

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