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Кафедра иностранных языков

ИНОСТРАННЫЙ ЯЗЫК

АНГЛИЙСКИЙ ДЛЯ ГЕОЛОГОВ

Методические указания к практическим занятиям для студентов специальности 21.05.02

FOREIGN LANGUAGE

ENGLISH FOR GEOLOGISTS

САНКТ-ПЕТЕРБУРГ
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ВВЕДЕНИЕ

Данные методические указания к практическим занятиям по английскому языку предназначены для студентов специальности 21.05.02 «Прикладная геология», специализация «Прикладная геохимия, петрология, минералогия». Методические указания составлены в соответствии с учебной программой по дисциплине «Иностранный язык» для формирования иноязычной профессиональной компетенции будущих специалистов.

В соответствии с программой методические указания содержат аутентичные тексты на английском языке с разработанным комплексом предтекстовых и послетекстовых упражнений. Изучение предложенного материала имеет целью развитие и совершенствование навыков чтения и перевода оригинальной научной литературы по геологии. Комплекс упражнений направлен на расширение словарного запаса, преодоление трудностей перевода и приобретение разговорных умений в сфере профессиональной деятельности.

Предложенные методические материалы предназначены для аудиторной работы студентов и состоят из трех разделов, содержащих информацию о геологии как науке и сферах ее практического применения. В состав настоящих методических указаний также входят тексты, содержащие информацию об особенностях внутреннего устройства планеты, минералах и основных типах горных пород. Грамматический раздел направлен на повторение таких тем как страдательный залог, модальные глаголы, неличные формы глагола.

UNIT 1 GEOLOGY AND ITS APPLICATIONS

TEXT 1.1 Geology

1 Read and translate the following words. Be careful to pronounce them correctly.

physical geology, historical geology, hazard, earthquake, volcano, volcanic eruption, slope failure, mountain, ocean, rock, mineral, mineral ore, marble, fossil, flood, flooding event

2 Give verbs corresponding to the following nouns:

implication, formation, observation, sedimentation, erosion, deposition

3 Match the verbs with the appropriate prepositions. Translate the word combinations.

a) act, make, deal, divide, move, come
b) up, forward (x2), into, upon/on, with

4 With a partner, discuss the questions below.

- What does geology study?
- What is physical geology concerned with?
- What does historical geology deal with?
- Who is considered to be the founder of Modern Geology? Why?
- What does *"Uniformitarianism"* mean?

5 Read the text to check your answers.

Geology is the study of the earth (*geo* means *earth*, and *ology* means *study of*). This is a very simple definition for something so complex. Geology involves studying the materials that make up the earth, the features and structures found on Earth as well as the processes that act upon them. Geology is also about discovering resources such as metals and energy; about recognizing and minimizing the environmental implications of our use of those resources; and about learning how to mitigate the hazards related to earthquakes, volcanic eruptions, and slope failures. Geology also deals with the study of the history of all life that's ever lived on or is living on the earth now. Studying how life and our planet have changed over time is an important part of geology.

Typically, geology is divided into two categories: physical geology and historical geology. Physical geology deals with the study of the physical features of the earth and the processes acting on them. This includes volcanoes, earthquakes, rocks, mountains and the oceans; just about any feature of the earth. Historical geology is the study of the history of the earth. Historical geologists focus on what's happened to Earth since its formation. They also study the changes in life throughout time. In historical geology, you essentially get to travel back in time to the formation of the earth and move forward through time, witnessing the changes in Earth itself and the life on it.

Geology has been of interest to humans as far back as ancient Greece in the 4th century. Aristotle was one of the first people to make observations about the earth. This was also the first time that scientists and philosophers noted a difference between rocks and minerals. The Romans became very adept at mining certain rock for use in building their empire, especially marble.

In the 17th century, fossils were being used as a way to understand what happened to the earth over time. In the 18th century, scientists started focusing on minerals and mineral ores since mining was an important part of global economies. During this century, two main theories came forward explaining some of the physical features of the earth. One theory believed that all rocks were deposited by the oceans during flooding events. The second theory believed that some rocks were formed through heat or fire.

This debate continued into the 19th century until James Hutton proved that some rocks are formed by volcanic (heat & fire) processes and others are formed by sedimentation. Hutton also explained that all the processes we see going on today, are the same processes that happened in the geologic past and that they occurred very slowly. In other words, the erosion that is occurring to our mountains today is the same process that eroded mountains in the past. This theory became known as Uniformitarianism, which simply stated says 'the present is the key to the past.' James Hutton is known as the Father of Modern Geology.

Taken from: https://study.com/academy/lesson/what-is-geology-definition-history-facts-topics.html

6 Give Russian equivalents of the following word combinations.

to make up the earth; to minimize the environmental implications; to mitigate the hazards; to deal with the study of; to focus on the formation of the earth; to move forward through time; to make observations about; to mine certain rock; to occur very slowly

7 Translate the sentences paying attention to the word *since*.

1. Historical geologists focus on what's happened to Earth **since** its formation. 2. In the 18th century, scientists started focusing on minerals and mineral ores **since** mining was an important part of global economies. 3. **Since** the mid-twentieth century, the troposphere as a whole has been warming, whereas the lower stratosphere has been cooling. 4. It is extremely likely that human influence has been the dominant cause of the observed warming **since** the mid-20th century. 5. **Since** there was no use for the heavier compounds of oil, such as asphalt and diesel fuel, this material was often simply burned near the well, creating awful palls of smog. 6. **Since** banded iron formations are all Precambrian, their origin might be connected to an ancient atmosphere or ocean chemically different from today's. 7. **Since** 1904, over 12 million tons of copper have been mined, processed, and sold. 8. **Since** they don't contain significant proportions of ices or gases, the inner planets are small relative to the more distant planets. 9. **Since** about 3.5 billion years ago, the Moon has experienced no major changes. 10. **Since** the underlying mantle rock was still very warm, the removal of overlying material allowed the mantle to melt, forming basaltic magma.

8 Fill in the gaps using the words in the box. Translate the text.

maintain	hazards	landforms	form	protect	benefit

Geology is the scientific study of Earth. We **1** _____ from geology in several ways: (1) We need geology to find and **2** _____ a supply of minable commodities and sources of energy; (2) Geology helps **3** _____ the environment; (3) Applying knowledge about geologic **4** _____ (such as volcanoes, earthquakes, tsunamis, landslides) saves lives and property; and (4) We have a greater appreciation of rocks and **5** _____ through understanding how they **6** _____.

TEXT 1.2 Geologist as a career

1 With a partner, discuss the questions below. Make a list of possible answers. Compare your ideas with other students.

- What do geologists study?
- Where can geologists work?

2 Read the text to check your answers.

Geology is a collection of disciplines. When someone decides to become a geologist, she or he is selecting one of those disciplines. The choice is very large. Some are financially lucrative; others may be less so but might be more satisfying. Following are a few of the areas in which geologists work.

Petroleum geologists work at trying to determine where existing oil fields might be expanded or where new oil fields might exist. A petroleum geologist can make over $90,000 a year but may have to spend months at a time on an offshore drilling platform. Mining geologists might be concerned with trying to determine where to extend an existing mine to get more ore or trying to find new concentrations of ore that are potentially commercially viable. Environmental geologists might work at mitigating pollution or preventing degradation of the environment. Marine geologists are concerned with understanding the sea floor. Some go down thousands of meters in submersibles to study geologic features on the sea floor. Hydrogeologists study surface and underground water and assist in either increasing our supply of clean water or isolating or cleaning up polluted water. Glaciologists work in Antarctica studying the dynamics of glacier movement or collecting ice cores through drilling to determine climate changes that have taken place over the past 100,000 years or more. Other geologists who work in Antarctica might be deciphering the history of a mountain range, working on skis and living in tents. Volcanologists sometimes are killed or injured while trying to collect gases or samples of lava from a volcano. Geophysicists interpret earthquake waves or gravity measurements to determine the nature of Earth's interior. Seismologists are geophysicists who specialize in earthquakes. Engineering geologists determine whether rock or soil upon which structures (dams, bridges, buildings) are built can safely support

those structures. Paleontologists study fossils and learn about when extinct creatures lived and the environment in which they existed.

Many geologists enjoy the challenge and adventure of field work, but some work comfortably behind computer screens or in laboratories with complex analytical equipment. Usually, a geologist engages in a combination of field work, lab work, and computer analysis.

Adapted from: Charles C. Plummer, Diane H. Carlson, Lisa Hammersley. (2016) Physical geology (Fifteenth edition), McGraw-Hill Education, New York. – p. 9

3 Read the text again and complete the table.

Working areas	***Professional activities***
Petroleum geologist …	determine where new oil fields might exist

4 Make a list of responsibilities you will have as a geologist. What kinds of work interest you the most? Explain your choice.

5 Study the diagram "Geology: Career Pathways" and write an essay of between 120 and 150 words "*My future career as a geologist".*

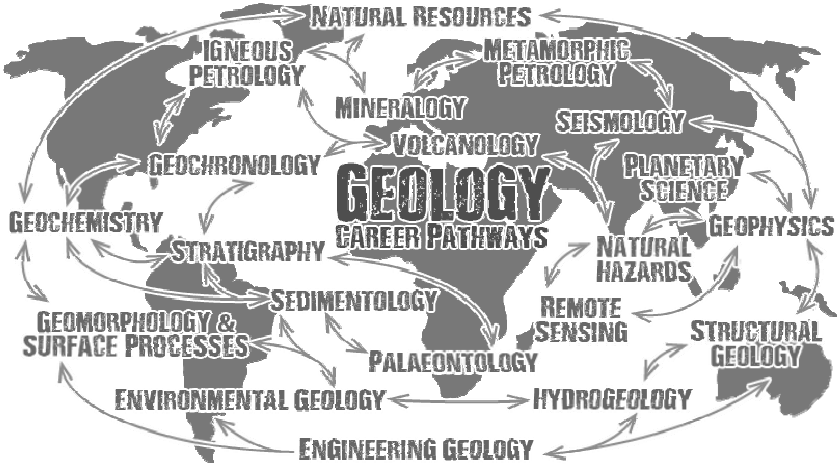


Fig.1. Geology: Career Pathways

6 Translate into Russian paying attention to the form of the verb-predicate in the Passive Voice.

1. One widely accepted hypothesis suggests that the magnetic field is created by electric currents within the liquid outer core. 2. The idea that plates move is widely accepted by geologists, although the reasons for this movement are debated. 3. Several techniques are being explored for scientifically forecasting a coming earthquake. 4. These soils and many others around the world are eroding at an alarming rate, much faster than they are being replaced by newly formed soils. 5. As the mountain belt is being compressed and shortening takes place, the central portion is pushed upward. 6. By coincidence, the world's deepest ice hole was being drilled from Vostok Station above the lake when the size of Lake Vostok was being determined. The hole was completed in 1998, producing one of the world's longest ice cores (over 3,500 km). 7. Another test of plate motion has been made by studying the seismicity of fracture zones. 8. Can anything be done to stop or slow down global warming? James Hansen thinks so. The rate at which methane and carbon dioxide are produced would have to be reduced. 9. The mechanical energy may be stored (an earthquake is a sudden release of stored mechanical energy) or converted to heat energy (rock may melt, resulting in volcanic eruptions).10. The drill bit must be made of special alloys to prevent it from becoming too soft to cut rock. 11. Minerals have a specific chemical composition that can be described by a chemical formula. 12. Most of the metamorphic rocks were originally sedimentary and volcanic rocks that had been deeply buried and subjected to intense stress and high temperature. 13. By the late 1960s, these ideas had been combined into a single theory that revolutionized geology by providing a unifying framework for Earth science—the theory of plate tectonics. 14. Continental glaciers, however, cannot move from sea onto land. If the two continents had been joined together, the ice that moved off Africa could have been the ice that moved onto South America. This hypothesis has now been confirmed; from their lithology, many of the boulders in South American tills have been traced to a source that is now in Africa. 15. Many Martian channels that were originally thought to have been carved by running water have since been reinterpreted. Some could have been formed by surface collapse caused by the melting of frozen water underground.

Terms to Remember

geology
historical geology
physical geology

to become a geologist
engineering geologist
environmental geologist
geophysicist
glaciologist
hydrogeologists
marine geologist
mining geologist
paleontologist
petroleum geologist
seismologist
volcanologist

to assist in
to be concerned with
to collect ice cores / samples of
to determine
to drill
to engage in
to interpret
to mine
to mitigate pollution
to prevent degradation of
to specialize in
to study geologic features
field work / lab work

deposition / to deposit
Earth's interior
earthquake
earthquake waves
erosion / to erode
flood
flooding event
formation of the earth / to form
fossil
glacier movement
hazard
landform
landslide
marble
mineral
mineral ore
mineral recourses
mountain
mountain range
observation / to observe
occurrence / to occur
ocean
offshore / onshore
oil field
rock
sedimentation
slope failure
soil
surface water
tsunami
underground water
volcanic eruption
volcano

UNIT 2 OUR PLANET

TEXT 2.1 The Physical Structure of the Earth

1 Fill in the gaps using the words in the box. There is one extra word.

A. Mantle	**B.** Outer core	**C.** Inner core	**D.** Lithosphere	**E.** Crust

The Earth is almost a sphere, consisting of four main layers.
1. _____ is made from solid nickel and iron
2. _____ has the properties of a solid, but can flow very slowly
3. _____ is relatively thin and rocky
4. _____ is made from liquid nickel and iron

2 Read the text to check your answers.

The Earth is an oblate spheroid. It is composed of a number of different layers as determined by deep drilling and seismic evidence. These layers are:

- The core which is approximately 7000 kilometers in diameter (3500 kilometers in radius) and is located at the Earth's center.
- The mantle which surrounds the core and has a thickness of 2900 kilometers.
- The crust floats on top of the mantle.

The core is a layer rich in iron and nickel that is composed of two layers: the inner and outer cores. The inner core is theorized to be solid with a density of about 13 grams per cubic centimeter and a radius of about 1220 kilometers. The outer core is liquid and has a density of about 11 grams per cubic centimeter. It surrounds the inner core and has an average thickness of about 2250 kilometers.

The mantle is almost 2900 kilometers thick and comprises about 83% of the Earth's volume. It is composed of several different layers. The upper mantle extends from the base of the crust downward to a depth of about 670 kilometers. This region of the Earth's interior is thought to be composed of peridotite, an ultramafic rock made up of the minerals olivine and pyroxene. The top layer of the upper mantle, 100 to 200 kilometers below surface, is called the asthenosphere. Scientific studies suggest that this layer has physical properties that are different from the rest of the upper mantle. The rocks in this upper portion of the mantle

are more rigid and brittle because of cooler temperatures and lower pressures. Below the upper mantle is the lower mantle that extends from 670 to 2900 kilometers below the Earth's surface. This layer is hot and plastic. The higher pressure in this layer causes the formation of minerals that are different from those of the upper mantle.

The lithosphere is a layer that includes the crust and the uppermost portion of the mantle (Fig. 2). This layer is about 100 kilometers thick and has the ability to glide over the rest of the upper mantle. Because of increasing temperature and pressure, deeper portions of the lithosphere are capable of plastic flow over geologic time. The lithosphere is also the zone of earthquakes, mountain building, volcanoes, and continental drift.

The topmost part of the lithosphere consists of crust. This material is cool, rigid, and brittle. Two types of crust can be identified: oceanic crust and continental crust (Fig. 2). Both of these types of crust are less dense than the rock found in the underlying upper mantle layer. Ocean crust is thin and measures between 5 to 10 km thick. It is also composed of basalt and has a density of 3.0 grams per cubic centimeter.

The continental crust is 20 to 70 kilometers thick and composed mainly of lighter granite. The density of continental crust is about 2.7 grams per cubic centimeter. It is thinnest in areas like the Rift Valleys of East Africa. Continental crust is thickest beneath mountain ranges and extends into the mantle. Both of these crust types are composed of numerous tectonic plates that float on top of the mantle. Convection currents within the mantle cause these plates to move slowly across the asthenosphere. *Taken from: http://www.physicalgeography.net/fundamentals/10h.html*

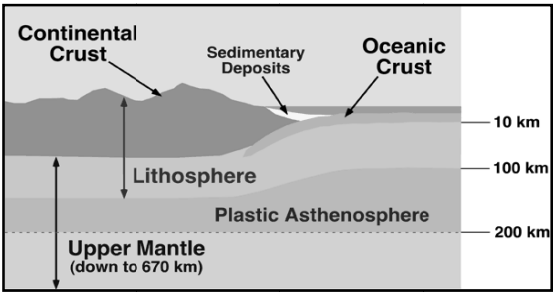


Fig. 2. Structure of the Earth's crust and top most layer of the upper mantle

3 Scan the text 2.1 and fill in the table below.

Elements and minerals mentioned in the text	*Granite, ...*
Physical properties mentioned in the text	*Rigid, ...*
Physical quantities mentioned in the text	*Density, ...*

4 Check your knowledge of the physical structure of our planet. Take turns asking each other questions and answer them. Give your partner one mark for each correct answer. Count your score at the end.

Student 1
- Which layer surrounds the core?
- Which layer contains most of the Earth's mass?
- Which type of the crust is rich in basalt?
- Which layer is made up mostly of iron?
- What causes the slow movements of tectonic plates across the asthenosphere?

Student 2
- What is the crust composed of?
- Which layer includes the crust and the uppermost part of the mantle?
- Which layer surrounds the inner core?
- Which layer floats on the top of the mantle?
- Which layer extends from 670 to 2900 km below the Earth's surface?

Take turns making up your own questions. Continue until one of you gives up. Who is the winner today? Who got the most right answers?

5 Translate the following sentences into Russian. Memorize constructions equivalent in meaning. Use them in sentences of your own.

1. The lithosphere	***consists of*** ***is composed of*** ***is built up of*** ***is made up of*** ***is formed of***	solid rocky material.
2. The lithosphere	***constitutes*** ***composes*** ***builds up*** ***makes up***	the solid earth.
3. The lithosphere	***comprises*** ***includes*** ***contains***	all the water on and near the earth's surface.

6 Translate the following sentences into Russian.

1. The crust of the lunar highlands **is composed of** silicate rocks, relatively rich in aluminum and poor in iron. 2. The lithosphere **is built up of** the

crust and the underlying, rigid mantle.3. Potassium feldspar, a very common mineral in the Earth's crust, **is made up of** the elements potassium, aluminum, silicon, and oxygen. 4. Gabbro **is formed of** coarse-grained ferromagnesian minerals and gray plagioclase feldspar. 5. Approximately one-sixth of the Moon's surface **consists of** nearly circular, dark-colored, smooth, relatively flat lava plains. 6. Sediment **includes** such particles as sand on beaches, mud on a lake bottom, boulders frozen into glaciers, pebbles in streams, and dust particles settling out of the air. 6. "Hard water" is water that **contains** relatively large amounts of dissolved calcium (often from the chemical weathering of calcite or dolomite) and magnesium (from the ferromagnesian minerals or dolomite).

7 Translate into English.

приблизительно 800 км, около 3 м, толщиной почти 2000 км, толщиной от 10 до 50 м, составляет около 40% объема, простираться на расстояние от 50 до 100 км, 2 м в диаметре, радиусом 5 км, 5 г/см^3, свыше 3 г/см^3

8 Tell about the physical structure of the Earth, using the diagram below.

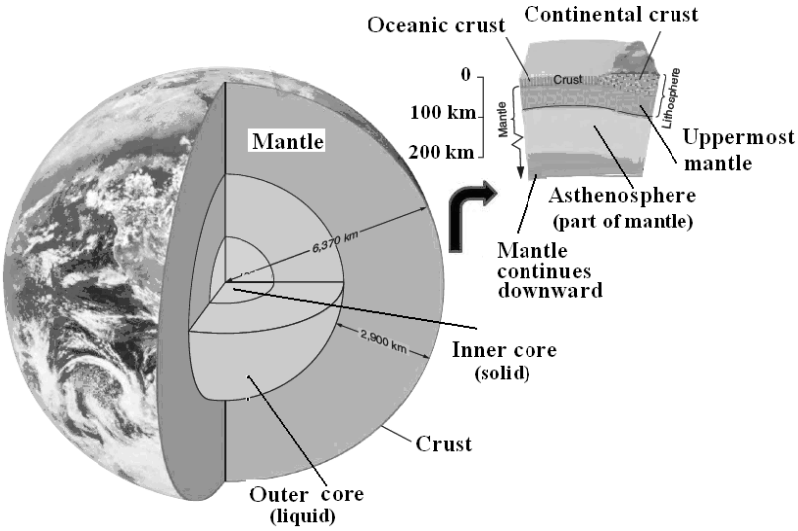


Fig. 3. Cross section through the Earth

9 Translate the sentences paying attention to the words in bold type.

1. The inner core **is theorized to be solid** with a density of about 13 grams per cubic centimeter. 2. This region of the Earth's interior **is thought to be composed** of peridotite. 3. Veins of quartz **are believed to be caused** by water that escapes from the magma. 4. The ash **is believed to cause** friction that generates an electrical charge. 5. The sedimentary rocks with marine fossils (clams, fish, etc.) that we find in mountains thousands of meters above sea level **were believed to have been deposited** by a worldwide flood (Noah's flood) that inundated all of Earth, including its highest mountains. 6. By early December, when the volcanic activity had subsided, 353 people **had been reported to be killed**. 7. Yellowstone and Long Valley calderas **are considered to be active** volcanoes, and volcanologists monitor them carefully. 8. Volcanoes that have not erupted in many thousands of years but that **are expected to** at some point in the future **are considered to be dormant**. 9. A sedimentary rock that consists of sediment grains bound by cement into a rigid framework **is said to have** a clastic texture. 10. A mineral **is said to be stable** if, given enough time, it does not react with another substance or convert to a new mineral or substance.

10 Translate the sentences paying attention to ***it ... that*****.**

1. **It is widely accepted that** the earth was originally in the form of a hot gaseous mass. 2. **It is believed that** the heat-loving, or thermophilic bacteria normally reside beneath the sea floor but are blown out of the hot spring when it erupts. 3. **It is suggested that** the shifting of water by tides can change the overlying water load or pressure on the ocean crust, which in turn could trigger movement in the crust. 4. Rocks dredged from seamounts are nearly always basalt, so **it is thought that** most seamounts are extinct volcanoes. 5. Scientists have conducted experiments showing that at high pressure, methane can convert to diamond. **It is believed that** diamonds may be "raining" down through the atmosphere of Uranus toward its core. 6. **It is believed that** most meteors are fragments of asteroids, although very few have been found to be fragments from the Moon or even Mars, probably blasted off the surface by a significant impact event. 7. **It is assumed that** the two types of crust are made up of different kinds of rock.

TEXT 2.2 The Water Cycle

1 Match the terms with their definitions.

A. Evaporation **C.** Precipitation **E.** Runoff
B. Condensation **D.** Infiltration **F.** Transpiration

1. It's the process where water vapors change into very tiny particles of ice /water droplets
2. It's the process of water movement through a plant and its evaporation from aerial parts, such as leaves, stems and flowers
3. It's the process of a substance in a liquid state changing to a gaseous state due to an increase in temperature and/or pressure
4. It's the process by which water soaks into subsurface soils and moves into rocks through cracks and pore spaces.
5. It's the process where water runs over the surface of earth
6. It's the falling of water from the sky in different forms

2 State to what part of speech the following words belong and translate them into Russian.

vapor – evaporate – evaporation – evaporating – evaporated; solid – solidify – solidification; transport – transportation – transporting – transported; condense – condenser – condensation – condensed; infiltrate – infiltrated – infiltration; form – formed – forming – formation; deposit – deposition – deposited – depositional; penetrate – penetration – penetrating; seep - seepage – seeping; soak – soakage – soaking

3 Read the text and label the diagram (fig. 4) below.

The hydrosphere is composed of all of the water on or near the earth. The total stock of it is approximately 1400 million km^3. This includes all forms of water in the oceans, rivers, lakes, and even the moisture in the air. Ninety-seven percent of the earth's water is in the oceans while the remaining three percent is fresh water for which three-quarters of the fresh water is solid and exists in ice sheets.

The water cycle, also known as the hydrological cycle, describes the continuous movement of water on, above and below the surface of the Earth. It includes the processes of evaporation, condensation, precipitation, infiltration, runoff, and subsurface flow.

Solar radiation provides the necessary energy for evaporation of water from the surface of the ocean. As moist air is lifted, it cools and water vapor condenses to form clouds. Moisture is transported around the globe until it returns to the surface as precipitation. Once the water reaches the ground, some of the water returns rather rapidly to the atmosphere by evaporation or transpiration from plants. The remainder either flows over the land surface as runoff in streams, or soaks into the ground by infiltration to form groundwater. Groundwater either seeps its way to into the oceans, rivers, and streams, or is released back into the atmosphere through transpiration. Groundwater is the second largest reserve of fresh water (0.76%) after glacial ice (1.76%), and represents an important source of drinking water along with surface water from streams and lakes (0.14%). Finally, most water eventually reaches the ocean, where ongoing evaporation completes the cycle.

Adapted from: https://www.ukessays.com/essays/environmental-sciences/hydrosphere-and-the-hydrologic-cycle-environmental-sciences-essay.php

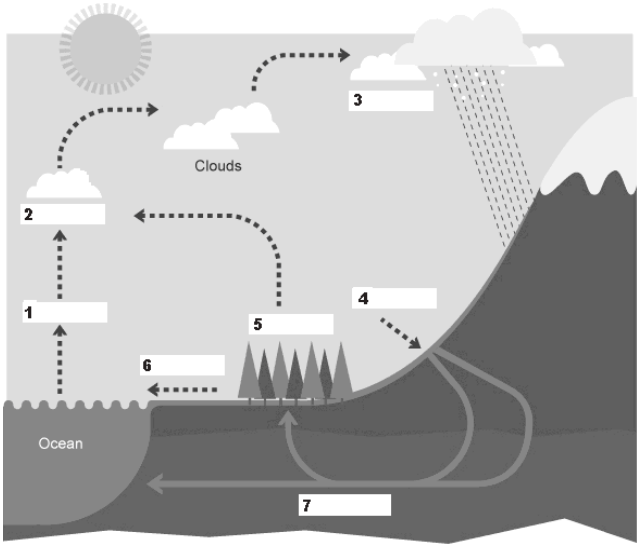


Fig. 4. The Water Cycle

4 Answer the questions.

1. What is the hydrosphere?

2. What percentage of the earth's water is salt water and fresh water?
3. What are the main steps of the water cycle?
4. What is the role of plants in the water cycle?
5.* Which process is the most important component in the water cycle?
6.* Can we influence the water cycle for benefit of human being?

5. Describe the water cycle using the diagram (see fig. 4).

6 Translate the following sentences paying attention to the words ending in *–ed*. Define their role in the sentences.

1. In time, a layer of sediment **deposited** on the sea floor becomes buried under another layer. 2. Sediment is **deposited** when the transporting agent loses its carrying power. 3. The dark-colored country rock is shale **deposited** in a marine environment. 4. The igneous rock, being out of equilibrium, may then undergo weathering and erosion, and the debris **produced** is **transported** and **deposited** (usually on a sea floor) as sediment. 5. Weathering products **transported** to the sea by rivers as dissolved solids make seawater salty and serve as nutrients for many marine organisms. 6. **Transported** soils do not develop from locally **formed** rock. 7. Because of wetter climate in the past, large lakes **formed** in now-arid regions of the United States. 8. Wind from the Gobi Desert carried the silt and clay that **formed** these deposits. 9. A striking but rare feature **formed** by longshore drift is a tombolo, a bar of sediment connecting a former island to the mainland. 10. Transportation is the movement of **eroded** particles by agents such as rivers, waves, glaciers, or wind. 11. Finally, the stream (the Colorado River) **eroded** its way through the rock, carving the Grand Canyon. 12. Rock debris **eroded** from above covers red beds *(красноцветные отложения).*13. Fiords are evidence that valleys **eroded** by past glaciers were later partly submerged by rising sea level. 14. Sedimentary rocks are **formed** from **eroded** mineral grains, minerals **precipitated** from low-temperature solution, or consolidation of the organic remains of plants. 15. As the water evaporates beneath the land surface, salts are **precipitated** within the soil. 16. Tsunami **generated** by submarine earthquakes may cause tremendous damage to the coastal environment. 17. An earthquake is a trembling or shaking of the ground **caused** by the sudden release of energy **stored** in the rocks beneath Earth's surface.

Terms to Remember

atmosphere
asthenosphere
hydrosphere
lithosphere
the Earth's center
the Earth's interior
the Earth's surface
core / inner core / outer core
crust / oceanic crust / continental crust
mantle / upper mantle / lower mantle

to be composed of
to be made up of
to consist of
to include
to rich in
to extend
to cause
to glide over
to float (on)

brittle
cool
dense / density
liquid
moist / moisture
ongoing
outermost
plastic
rigid
thick
thin
topmost
uppermost

hydrological cycle / water cycle
condense / condensation
evaporate / evaporation / water vapor
infiltrate / infiltration
penetrate / penetration
runoff
seep / seepage
soak / soakage
solidify / solidification / solid
transpiration
transport / transportation

drinking water
fresh water
groundwater

basalt
granite
iron
nickel
olivine
peridotite
pyroxene
ultramafic rock

cloud
continental drift
convection currents
glacial ice
ice sheet
oblate spheroid
seismic evidence
stream
tectonic plate

UNIT 3 ROCKS AND MINERALS

TEXT 3.1 Difference between Rocks and Minerals

1 Discuss these questions with a partner.

- What is the difference between rocks and minerals?
- How many types of rocks make up the Earth's crust?
- What are the names of the three types of rocks?
- How are they formed?

2 Read the text to check your answers.

The ground we walk on, build on, and grow gardens on is made of rock. All the rocks in the world are made up of chemicals called minerals. Minerals are solid, inorganic (not living) substances found in and on the earth. Most are chemical compounds, which means that they are made of two or more elements. For example, the mineral sapphire is made up of aluminum and oxygen. A few minerals such as gold, silver and copper are made of a single element. Minerals are considered to be the building blocks of rocks. Rocks can be a combination of as many as six types of minerals. Through a microscope, a rock shows that it is made of crystals of different minerals, all growing together like a puzzle.

Three types of rocks make up the Earth's crust. Rocks are formed in three different ways to produce igneous, metamorphic, and sedimentary rocks. Igneous rocks form when molten magma cools and solidifies. Metamorphic rocks form when a rock is chemically changed by heat or pressure to form a new rock type. Sedimentary rocks form when fragments of rocks and other debris are cemented together.

Taken from: www.k5learning.com

2 Give the Russian for:

to be made up of chemicals; solid substances; chemical compounds; a few minerals; the building blocks of rocks; make up the Earth's crust; to be formed in three different ways; igneous rocks; molten magma; to cool; to solidify; metamorphic rocks; to be chemically changed; sedimentary rocks; to form; debris

3 Read the text again and complete the table below.

Elements	Minerals	Types of Rocks

TEXT 3.2 Minerals

1 Read and translate the following words. Be careful to pronounce them correctly.

hydrocarbon (n)	[hʌɪdrə(ʊ)ˈkɑːb(ə)n]	halite (n)	[ˈhælaɪt]
sodium (n)	[ˈsəʊdɪəm]	chlorine (n)	[ˈklɔːriːn]
potassium (n)	[pəˈtæsiəm]	aluminum (n)	[əˈluːmɪnəm]
silicon (n)	[ˈsɪlɪkən]	oxygen (n)	[ˈɒksɪdʒ(ə)n]

2 Translate the following word combinations from the text.

the building blocks of the rocks; the origin of our world; Earth-like planets; naturally occurring; formed naturally; a specific chemical composition; complex molecules; true minerals; manufactured minerals; common minerals; attributes of a mineral; three-dimensional pattern

3 Read the text and complete the sentences below.

1) Naturally occurring means …
2) Inorganic means …
3) Crystalline means …
4) A specific chemical composition means …

The study of minerals is called mineralogy. To geologists, minerals are important because they are the building blocks of the rocks that make up the Earth. The minerals in rocks tell a very important story about the origin of our world and, indeed, about all Earth-like planets.

Minerals are defined as naturally occurring, inorganic, crystalline solids that have a specific chemical composition.

Naturally occurring tells us that a mineral must form through natural geologic processes. Synthetic diamonds, while possessing all of the other attributes of a mineral (inorganic, crystalline, specific chemical composition) cannot be considered true minerals because they are not formed naturally. Manufactured minerals are referred to as synthetic minerals. Inorganic means that minerals are not composed of the complex hydrocarbon molecules that are the basis of life-forms such as humans and plants. Minerals have a specific chemical composition that can be described by a chemical formula. Chemical formulas tell you which elements are in the mineral and in what proportion. For example, the com-

mon mineral halite (rock salt) has a chemical composition of NaCl. It is made of the two elements sodium and chlorine with one sodium atom for every atom of chlorine. Many minerals contain more than just two elements. Potassium feldspar, a very common mineral in the Earth's crust, is made up of the elements potassium, aluminum, silicon, and oxygen. All minerals have a crystalline structure where the atoms that make up the mineral are arranged in an orderly, repeating, three-dimensional pattern.
Adapted from: Charles C. Plummer, Diane H. Carlson, Lisa Hammersley. (2016) Physical geology (Fifteenth edition), McGraw-Hill Education, New York. – p. 26

4 Quiz "Physical Properties of Minerals"

Each type of mineral is distinguished by a combination of properties, some of which we can see with the unaided eye, others of which are discernable only at the microscopic and atomic levels. Examples of these properties include color, luster, hardness, chemical composition, and the transmission of light under a microscope.

Match the physical properties of minerals with their definitions. Then cover the second column of the table and explain the terms in the first column in your own words.

1	luster	**A**	the color of the powder formed when a mineral is crushed
2	cleavage	**B**	a set of faces that have a definite geometric relationship to one another
3	streak	**C**	the way a substance breaks where not controlled by cleavage
4	hardness	**D**	the quality and intensity of light that is reflected from the surface of a mineral
5	specific gravity	**E**	the ratio of a mass of a substance to the mass of an equal volume of water
6	fracture	**F**	the property of scratchability
7	the crystal form of a mineral	**G**	the ability of a mineral to break, when struck or split, along preferred planar directions

5 Decide whether the statements are *TRUE* (T) or *FALSE* (F).

1. Minerals are inorganic elements that come from the earth.
2. In order to identify a mineral, it is necessary to determine its chemical composition.
3. All minerals have cleavage.

4. Crystal form refers to the angles between crystal faces, not to the absolute size and shape of a crystal.
5. Sulfates are the most common minerals in the earth's crust.
6. James Dana developed a classification scheme for minerals based on chemical composition.
7. Mineralogists are called professional rock experts.
8. Pumice can float on water.
9. All minerals are chemical compounds.
10. A mineral can be liquid, solid, or gas.

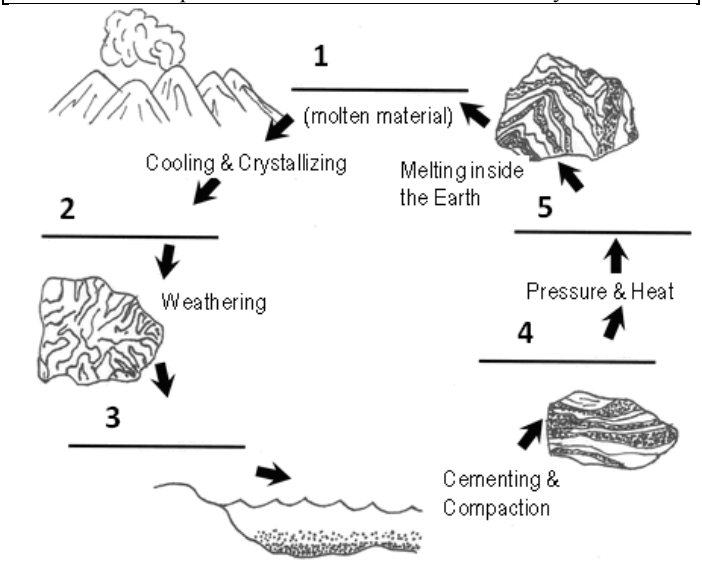
6 Translate into Russian paying special attention to modal verbs and their equivalents.

1. Sedimentary rock that becomes deeply buried in the Earth **may** later be transformed by heat and pressure into metamorphic rock. 2. Note that the third most abundant element is aluminum, which is more common in rocks than iron. Knowing this, one **might** assume that aluminum **would** be less expensive than iron. 3. Experiments have confirmed that most of the minerals in these rocks **can** form only at high temperatures. Other experiments indicate that some of the minerals **could** have formed only under high pressures, implying they were deeply buried. 4. Magma solidifying to granite, being chemically similar, **should** be equally viscous. 5. As geologists learn more about earthquake behavior, the possibility exists that we **will be able to** forecast earthquakes. 6. Geologists **have to** rely on small samples of rock taken from the sea floor and brought to the surface, or they **must** study the rocks indirectly by means of instruments on board ships. 7. Extra water **may be allowed t**o seep into the soil. 8. A geologist **may have to** become a proficient mountain climber to access the good exposures. 9. These resources **have to** be mined and processed by machinery made of iron in factories powered by electricity. 10. The industrial world **will have to** find a new energy source. 11 All of the water for the great glaciers **had to** come from somewhere. 12. It **is to** be understood that weathering is ordinarily a complex process in which many different agents co-operate. 13. If we **are to** understand the origin and classification of rocks, we **must** learn something about the various minerals that compose them.

TEXT 3.3 The Rock Cycle

1 Fill in the blanks to complete the rock cycle using the words in the box.

magma	igneous rock	sediment
metamorphic rock		sedimentary rock



2 Describe the rock cycle using the following verbs. Put them into the passive where necessary.

uplift, solidify, expose (to); undergo; produce; transport; deposit; consolidate; recrystallize; melt; create

3 Scan the text to find out the difference between magma and lava; extrusive and intrusive igneous rocks.

Igneous rocks form when magma solidifies. If the magma is brought to the surface (where it is called lava) by a volcanic eruption, it will solidify into an extrusive igneous rock. Magma may also solidify very slowly beneath the surface. The resulting intrusive igneous rock may be exposed later after uplift and erosion remove the overlying rock. The igneous rock, being out of equilibrium, may then undergo weathering and

erosion, and the debris produced is transported and ultimately deposited (usually on a sea floor) as sediment. If the unconsolidated sediment becomes lithified (cemented or otherwise consolidated into a rock), it becomes a sedimentary rock. The rock is buried by additional layers of sediment and sedimentary rock. This process can only bury layered rock in the uppermost crust to a depth of several kilometers. Tectonic forces are required to transport sedimentary (and volcanic) rock to lower levels in the crust. Heat and pressure increase with increasing depth of burial. If the temperature and pressure become high enough, as occurs in the middle and lower levels of continental crust, the original sedimentary rock is no longer in equilibrium and recrystallizes. The new rock that forms is called a metamorphic rock. If the temperature gets very high, the rock partially melts, producing magma and completing the cycle.

The cycle can be repeated. However, there is no reason to expect all rocks to go through each step in the cycle. For instance, sedimentary rocks might be uplifted and exposed to weathering, creating new sediment.

Adapted from: Charles C. Plummer, Diane H. Carlson, Lisa Hammersley. (2016) Physical geology (Fifteenth edition), McGraw-Hill Education, New York. – p. 52.

4 Match the word combinations with similar meanings.

1	to be brought to the surface	**A**	to be deposited
2	to solidify	**B**	fragments of rock
3	to be exposed to smth.	**C**	to move
4	to be buried	**D**	to melt
5	to transport	**E**	to be uplifted
6	to be produced	**F**	to complete
7	debris (n)	**G**	to become lithified
8	to thaw	**H**	unconsolidated
9	to finish	**I**	to undergo smth.
10	loose (adj.)	**J**	to be created

5 Translate the text in 3 from English into Russian.

6 Translate the sentences paying attention to the Participle I used attributively and adverbially.

1. If you go to the island of Hawaii, you might observe red-hot lava **flowing** over the land and, as it cools, **solidifying** into the fine-grained, black rock we call basalt. 2. If a **moving** glacier reaches a body of water, blocks of ice break off and float free as icebergs. 3 Magma is molten rock, usually rich in silica and **containing** dissolved gases. 4. The Earth's crust is a thin skin of rock, **making up** less than 1% of Earth's total volume. 5. Glaciers in temperate climates—where the temperature of the glacier is at or near the **melting** point for ice—tend to move faster than those in colder regions—where the ice temperature stays well below freezing. 6. The ice in permafrost is a **cementing** agent for the soil. 7. The minerals **making up** igneous rocks crystallize at relatively high temperatures and sometimes at high pressures as magma and lava cool. 8. For centuries, the Chinese have dug cavelike homes in loess cliffs. When a large earthquake shook China in 1920, however, many of these cliffs collapsed, **burying** alive about 100,000 people. 9. The **sloping** bottom wedges the **moving** water upward, increasing the wave height. 10. When **moving,** cold masses of air chill warmer air masses.

7 Analyse all the *"ing-forms"* **in the text in 3. State whether the** *"ing-form"* **is a participle, gerund or verbal noun. State the function of the participles.**

8 Translate the following word combinations paying attention to the Participle I and Participle II used attributively.

a) rocks **formed** deep in Earth; landforms **altered** by mechanical and chemical weathering; mechanical weathering largely **caused** by frost action and pressure; the remains of organisms **preserved** in sedimentary rock; the granules of minerals **compacted** and weakly **cemented** together by ice; sediment **transported** to the lake; mineral ores widely **utilized** by man

b) the likelihood of a large earthquake **occurring** again; the erosional agent **shaping** the Earth's land surface; a divergent plate boundary **forming** in the middle of a continent; crystals **precipitating** during evaporation of water; water **infiltrating** the soil during the gentle rainfall; field of science **relating** to the origin of the earth and other planets

Terms to Remember

aluminum
chlorine
copper
diamond
feldspar
halite (rock salt)
oxygen
potassium
sapphire
silicon
sodium

chemical composition
chemical compound
cleavage
combination of properties
crystal form of a mineral
crystalline solid
crystalline structure
fracture
hardness
inorganic substance
luster
naturally occurring
powder
scratchability
specific gravity
streak
three-dimensional pattern
transmission of light
unconsolidated / loose
Earth-like planet
sea floor
tectonic force

the rock cycle
depth of burial
debris
fragments of rocks
igneous rock
intrusive / extrusive igneous rock
metamorphic rock
metamorphic rock
sediment / layer of sediment
sedimentary rock
overlying rock
weathering

to be arranged in
to be buried
to be cemented together
to be chemically changed
to be deposited
to be distinguished by
to be exposed (to)
to be in (out of) equilibrium
to be made up of chemicals
to be uplifted / uplift
to become lithified / lithification
to be consolidated into a rock
to melt / molten magma
to recrystallize
to undergo
mineralogy
attribute of a mineral
common mineral
manufactured mineral
synthetic mineral
true mineral

APPENDIX

Варианты экзаменационных заданий на перевод

Read and translate the texts from Russian into English.

UNIT 1

Text 1 **Geology** is the study of the Earth, the materials of which it is made, the structure of those materials, and the processes acting upon them. It includes the study of organisms that have inhabited our planet. An important part of geology is the study of how Earth's materials, structures, processes and organisms have changed over time.

Many processes such as landslides, earthquakes, floods, and volcanic eruptions can be hazardous to people. Geologists work to understand these processes well enough to avoid building important structures where they might be damaged. If geologists can prepare maps of areas that have flooded in the past, they can prepare maps of areas that might be flooded in the future. These maps can be used to guide the development of communities and determine where flood protection or flood insurance is needed.

Adapted from: https://geology.com/articles/what-is-geology.shtml

Text 2 **A petroleum geologist** is involved in identifying possible oil deposits/traps, oil discovery, and production. They are called upon to study sediment deposits in oceans, rock folds, and faults. They also make the decision of where to drill by locating prospects within a sedimentary basin. This can be very labour-intensive work that involves special equipment to look at sedimentary and structural aspects in order to locate possible oil traps.

Petroleum geologists determine a prospect's viability by looking for: a source rock that can generate hydrocarbons; porous rock reservoirs that are sealed and that collect hydrocarbons in a trap; traps that are formed in a specific geological order; a cracking of organic matter into gas and oil when under heat and pressure; and the movement of gas and oil from the source rock- to a reservoir rock- to a trap.

Adapted from: https://www.careerexplorer.com/careers/geologist/

UNIT 2

Text 1 There are two very different **types of crust**, each with its own distinctive physical and chemical properties. Oceanic crust is composed of magma that erupts on the seafloor to create basalt lava flows or cools deeper down to create the intrusive igneous rock gabbro. Sediments, primarily muds and the shells of tiny sea creatures, coat the seafloor. Sediment is thickest near the shore where it comes off the continents in rivers and on wind currents. Continental crust is made up of many different types of igneous, metamorphic, and sedimentary rocks. The average composition is granite, which is much less dense than the mafic igneous rocks of the oceanic crust. Because it is thick and has relatively low density, continental crust rises higher on the mantle than oceanic crust, which sinks into the mantle to form basins. When filled with water, these basins form the planet's oceans.

Adapted from: https://courses.lumenlearning.com/geophysical/chapter/the-composition-and-structure-of-earth/

Text 2 The Sun is the main energy to drive the whole **hydrological cycle**. Water takes up heat and evaporates as water vapor into the air. Water can be released out from plants through transpiration. Ice and snow can change to gaseous form by sublimation. Water vapor is transferred by air to different latitudes. They condense and fall as precipitation in the form of rain, snow, hail and sleet. The water can be stored in solid form as ice caps and glaciers for thousands of years. Most water falls back into the oceans or onto land as rain. The water flows over the ground is known as surface runoff and part of it flows into rivers. Much of it soaks into the ground as infiltration. Runoff and groundwater are stored as freshwater in lakes. Over time, the water returns to the ocean, where our water cycle started.

Taken from: https://www.ukessays.com/essays/environmental-sciences/hydrosphere-and-the-hydrologic-cycle-environmental-sciences-essay.php

UNIT 3

Text 1 **Rocks** are defined as naturally formed aggregates of **minerals** or mineral-like substances. The granite therefore, is a rock that is made up of the minerals quartz, plagioclase feldspar, potassium feldspar, and biotite. A rock can be composed of a single mineral. For example, limestone

is composed of the mineral calcite. The reason that limestone is a rock and not defined simply as the mineral calcite is that the limestone is made up of multiple crystals of calcite either grown in an interlocking pattern or cemented together. Although limestone is made up of a single mineral type, it is still an aggregate of many mineral grains. Some rocks can be composed of non-mineral substances. For example, coal is made of partially decomposed organic matter. Obsidian is made of silica glass, which is not crystalline and therefore not a mineral.

Adapted from: Charles C. Plummer, Diane H. Carlson, Lisa Hammersley. (2016) Physical geology (Fifteenth edition), McGraw-Hill Education, New York. – p. 27

Text 2 It is important to note that the physical characteristics of **minerals** that we can observe without complex laboratory equipment, such as color, hardness, and luster, are linked closely with the crystalline structures and chemical compositions of the minerals. Some minerals can have the same chemical composition but have different crystalline structures—described as polymorphism. Graphite and diamond are particularly spectacular example of polymorphism. Both minerals are made up of elemental carbon. They are unusual in that there is no other element involved in their structures. Besides their extreme differences in hardness, graphite is dark and appears metallic while diamond is usually transparent and has a brilliant luster. Graphite's crystal structure is sheetlike, and it forms within the crust, while diamond originates much deeper, under the higher pressure conditions of the mantle.

Adapted from: Charles C. Plummer, Diane H. Carlson, Lisa Hammersley. (2016) Physical geology (Fifteenth edition), McGraw-Hill Education, New York. – p. 38

Text 3 Just like plants and animals have a life cycle, rocks can go through a **rock cycle**! Many rocks start from magma or lava, so they are igneous rocks. The igneous rocks could get broken up in a river or stream and settle to the bottom of a lake. Over thousands or millions of years, the broken up rocks could get compacted into a sedimentary rock. The sedimentary rock could get exposed to intense heat, and change to a metamorphic rock. Then the metamorphic rock could get covered by many other rocks and end up deep in Earth's crust. It may melt and turn into magma, and the cycle could start over again. The rock cycle is different

than a life cycle of a plant or animal, though, because a rock doesn't have to go through the cycle in order, and it may not go through all the stages.
Taken from: www.k5learning.com

Text 4 The three main **types of rocks** are sedimentary, metamorphic, and igneous. The differences between them have to do with how they are formed. Sedimentary rocks are formed from particles of sand, shells, pebbles, and other fragments of material. Metamorphic rocks arise from the transformation of existing rock types, in a process called metamorphism, which means "change in form". Igneous rocks are formed when magma cools and hardens. All rocks are continually changing from one type to another and back again, as forces inside the earth bring them closer to the surface (where they are weathered, eroded, and compacted) and forces on the earth sink them back down (where they are heated, pressed, and melted). So the elements that make up rocks are never created or destroyed — instead, they are constantly being recycled.

ANSWER KEY

UNIT 1

TEXT 1.1: Geology

Ex. 2: implication – to implicate; formation – to form; observation – to observe; sedimentation – to sediment; erosion – to erode; deposition – to deposit

Ex. 3: act upon/on – *воздействовать на*; make up - *составлять*; deal with - *заниматься вопросами*; divide into – *разбивать / разделять на*; move forward - *двигаться вперед*; come forward - *выдвинуться, стать популярным, войти в моду*

Ex. 8: 1. benefit 2. maintain 3. protect 4. hazards 5. landforms 6. form

UNIT 2

TEXT 2.1: The Physical Structure of the Earth

Ex. 1: 1C, 2D, 3E, 4B

Ex. 7: approximately 800 kilometers, about 3 meters, almost 2000 kilometers thick, 10 to 50 meters thick, comprise about 40 percent of volume, extend from 50 to 100 kilometers, 2 meters in diameter, 5 kilometers in radius, 5 grams per cubic centimeter, over 3 grams per cubic centimeter

TEXT 2.2: The Water Cycle

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

Ex. 3: 1. Evaporation; **2.** Condensation; **3.** Precipitation; **4.** Infiltration; **5.** Transpiration; **6.** Runoff; **7.** Subsurface flow (groundwater)

UNIT 3

TEXT 3.1: Difference between Rocks and Minerals

Ex. 3:

Elements: aluminum, oxygen

Minerals: sapphire, gold, silver and copper

Types of Rocks: igneous, metamorphic, and sedimentary rocks

TEXT 3.2: Minerals

Ex. 4 (Quiz): 1D 2G 3A 4F 5E 6C 7B

Ex. 5:

1. **True.**

2. **False.** *Luckily, the most common minerals can be quickly identified in the field using basic physical properties such as color, shape, and hardness.*
3. **False.** *Some minerals don't have any planes of weakness in their atomic structure. These minerals don't have any cleavage. Instead, they fracture.*
4. **True.** *The external shape of a mineral crystal, or its crystal form, is determined largely by its internal atomic structure, defined by the relationships between angles on the crystal faces. Thus, the angle between the crystal faces will always be the same no matter the size of the crystal.*
5. **False.** *The most common minerals are the silicates, which make up 90% of the Earth's crust.*
6. **True.** *James Dana, a mineralogist at Yale University from 1850 to 1892, developed a classification system for minerals based on chemical composition. He grouped minerals according to whether they were oxides, silicates, sulfates, etc. His system has survived to the present day.*
7. **False.** *A mineralogist studies and classifies minerals. A petrologist is a geologist who specializes in petrology (the study of the origin, composition and structure of rock).*
8. **True.** *Pumice is a light-colored, extremely porous igneous rock. Many specimens have a high enough porosity that they can float on water until they slowly become waterlogged.*
9. **False.** *All minerals have a specific chemical composition. The mineral silver is made up of only silver atoms and diamond is made only of carbon atoms, but most minerals are made up of chemical compounds.*
10. **True.** *The term mineral is usually used to describe rocks, which are solid, however, at a sufficiently high temperature, any mineral will melt, and at an even higher temperature, any mineral will vaporize. So yes, a mineral can be liquid, solid, or gas.*

Taken from: https://www.visionlearning.com/en/library/Physics/6/Properties-of-Minerals/130/quiz

TEXT 3.3: The Rock Cycle

Ex. 1: 1 – magma, 2 – igneous rock, 3 – sediment, 4 – sedimentary rock, 5 – metamorphic rock

Ex. 4: 1E 2G 3I 4A 5C 6J 7B 8D 9F 10H

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