МИНОБРНАУКИ РОССИИ

Федеральное государственное бюджетное образовательное учреждение высшего образования "Пермский государственный национальный исследовательский университет"

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Рабочая программа дисциплины

STUDY OF GEOSPHERES

Код УМК 95047

Утверждено
Протокол №9
от «16» апреля 2019 г.

Пермь, 2019

1. Наименование дисциплины

Study of geospheres

2. Место дисциплины в структуре образовательной программы

Дисциплина входит в обязательную часть Блока « Б.1 » образовательной программы по направлениям подготовки (специальностям):

Направление: **05.03.06** Экология и природопользование

направленность Экологическая инженерия и новая энергетика

3. Планируемые результаты обучения по дисциплине

В результате освоения дисциплины **Study of geospheres** у обучающегося должны быть сформированы следующие компетенции:

05.03.06 Экология и природопользование (направленность : Экологическая инженерия и новая энергетика)

ОПК.3 знать основные теории, учения и концепции в профессиональной области

ОПК.5 владеть современными методами естественнонаучных исследований, анализа данных, проектирования

ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении

4. Объем и содержание дисциплины

Направления подготовки	05.03.06 Экология и природопользование (направленность: Экологическая инженерия и новая энергетика)
форма обучения	очная
№№ триместров, выделенных для изучения дисциплины	4,5,7,8
Объем дисциплины (з.е.)	12
Объем дисциплины (ак.час.)	432
Контактная работа с преподавателем (ак.час.), в том числе:	168
Проведение лекционных занятий	56
Проведение практических занятий, семинаров	112
Самостоятельная работа (ак.час.)	264
Формы текущего контроля	Защищаемое контрольное мероприятие (5) Итоговое контрольное мероприятие (4) Письменное контрольное мероприятие (16)
Формы промежуточной аттестации	Экзамен (4 триместр) Зачет (5 триместр) Зачет (7 триместр) Экзамен (8 триместр)

5. Аннотированное описание содержания разделов и тем дисциплины

Study of geospheres. Study of atmosphere

Lectures and practices comprises the thermodynamics, and dynamics of the troposphere. The governing conservation (balance) equations for
trace constituents, dry air, water substances, total mass (equation of continuity), energy (1st law of thermodynamics), entropy (2nd law of thermodynamics), and
momentum (Newton’′s 2nd axiom) are presented and explained. This presentation includes simplifications like the hydrostatic and geostrophic approximations and
their application in models. Static and conditional stability criteria are explained too. Phenomena discussed include, for instance, atmospheric waves and their analytical
solutions, frontal systems, hurricanes, föhn wind systems (Chinook), classical and non-classical mesoscale circulations, the global circulation and circulation systems
(e.g. El Niño Southern Oscillation). Basic principles of climatology and data analysis are introduced as well.

Air and Atmosphere

It discusses the vertical structure of the atmosphere under different aspects (temperature, pressure, composition, magnetism, ionization): atmospheric structure, atmospheric composition, inert and reactive gases.

Thermodynamics of Atmosphere

We are given provides the fundamentals of the thermodynamics of irreversible processes as they are used in meteorology. The discussion includes
the laws of thermodynamics, kinetic gas theory, atmospheric stability, and thermodynamics charts. The idea of an air parcel and various thermodynamic
systems as they are used in meteorology and climate modeling are introduced as well. Both adiabatic and diabatic processes are discussed. Thermodynamic
potentials are introduced for explanation of thermodynamical, dynamical and chemical concepts throughout the book.

Vertical Structure of the Atmosphere

We can describe the vertical structure of the atmosphere by its composition, thermal state, pressure (force per area), escape velocity, ionization, and the strength of the magnetic field.

Basic Definitions of Thermodynamics

Introducing meteorological concepts requires discussing basics of thermodynamics. Thermodynamics is an axiomatic science based on fundamental principles that themselves are no longer explainable. We are given defines the termini of thermodynamics required in meteorology.

Equation of State

The ideal gas; the universal gas constant; the individual gas constant; the air density and the specific volume; the units of density measurement; the absolute thermodynamic scale; the partial pressure.

Hydrostatic Equation

The hydrostatic equation; normal pressure; the vertical pressure gradient; geopotential height; the dependence of the vertical pressure gradient on the air temperature.

Barometric Pressure Adjusted to Sea Level

The barometric equation; the barometric equation of isothermal atmosphere; the hypsometric equation; the barometric equation of homogeneous atmosphere; the barometric equation of polytropic atmosphere;

First Law of Thermodynamics

We are given definition of first law of thermodynamics, equivalence of heat and work done, application of the

first law of thermodynamics
to meteorology, kinetic theory of heat, specific heat, potential temperature and applications of potential temperature.

Thermodynamic Diagrams. Stratification and Stability
The level of condensation; the moist adiabatic process; the pseudo-adiabatic process; the equivalent potential temperature; convective instability; convective neutrality; convective stability; convective available potential energy; the potential temperature; equivalent potential temperature.

Second Law of Thermodynamics
The second law of thermodynamics is an axiom that tells us how heat is transformed into work.30 The second law of thermodynamics postulates the impossibility to construct a periodically working engine that does nothing else than cooling a heat reservoir and transferring the heat change into work. During real processes the entropy of a closed system increases. From a molecular point of view, the second law of thermodynamics is a matter of high probability, but not of absolute certainty.

Latent Heat
The latent heat; Clausius-Clapeyron Equation; Magnus formula; relative humidity.

Vertical Temperature Gradients and Mixing in a Moist Atmosphere
As phase transition depends on moisture and temperature, we discuss the change of these quantities with height. Dew-point temperature gradient; saturation adiabatic temperature gradient. Vertical mixing, forced ascends at a mountainous barrier, frontal lifting and convergence of the horizontal wind field (e.g. low pressure systems, squall lines, thunderstorms, local convection) are mechanisms to lift air so that condensation/deposition occurs. Vertical mixing occurs because of turbulent and/or convective processes.

Clouds and Precipitation
This lecture introduces the theoretical basis of the seven microphysical processes and the terms of their sub-processes. It discusses the concepts of conservation of total water mass, as well as bulk-parameterizations and spectral cloud models. The various cloud types and cloud morphology as a result of their microphysical properties and formation processes are presented as well.

Nucleation of Liquid Droplets
Nucleation is the process when water-vapor molecules accumulate to build an initial drop or ice crystal. In the air, water molecules collide randomly and build embryo droplets. We call this process homogeneous nucleation in the case of pure water, and heterogeneous nucleation when a droplet or ice crystal form on a cloud condensation nuclei (CCN) or ice nuclei (IN), respectively. Homogeneous nucleation rarely occurs in the atmosphere because it requires extremely high super-saturation values non-existent in the atmosphere. Nevertheless, discussing homogeneous nucleation provides valuable insight on nucleation.

Water-vapor diffusion
Water-vapor diffusion can be directed towards the particle (condensation or deposition) or from a particle into its environment (evaporation or sublimation). The binding forces of ice are stronger than those of water, the saturation pressure of water exceeds that of ice, the saturation pressure over a concave surface exceeds that over a convex surface, and the saturation pressure is higher for pure water than for a solute have consequences for mixed phase clouds.

Deposition and Sublimation
Diffusion growth of an ice crystal; the water-vapor diffusion onto ice crystals; the Bergeron-Findeisen-Wegner process.

Accretion and Coalescence
The coalescence; collection kernel; the aerodynamic effects of coalescence; coalescence efficiency.

Aggregation and Riming
The aggregation; the riming; the hail dry growth and wet growth.

Raindrop Breakup
The falling drop; breakup; the maximum stable radius for a drop.

Solar Constant and Insolation
The actual distance between the Sun's center and the orbit of the Earth. The orbital effect. Elements of the Earth-Sun geometry. The solar constant. Insolation.

Blackbody Radiation
This covers the nomenclature and basic quantities used in meteorology to describe the atmospheric radiation processes. The principle of blackbody radiation are applied to the atmosphere. Planck's law. The Boltzmann constant. The Planck function. The Rayleigh-Jeans law. The exponential law of Wien and Paschen. The brightness temperature. Wien's displacement relationship. The power law of Stefan and Boltzmann. Kirchhoff's law. The gray bodies; the relative spectral emittance.

Shortwave Radiation
This covers the nomenclature and basic quantities used in meteorology to describe the atmospheric radiation processes. The principle of shortwave radiation are applied to the atmosphere. Scattering; single scattering and multiple scattering; independent scattering. Geometric Optics: halos, the albedo and a secondary rainbow, ideal diffuse reflector. Mie scattering. Rayleigh scattering. Diffraction. Absorption.

Long-wave Radiation
This covers the nomenclature and basic quantities used in meteorology to describe the atmospheric radiation processes. The principle of long-wave radiation are applied to the atmosphere. In accord with the Stefan-Boltzmann's law, and Wien's displacement law all components of the climate system emit radiant energy in the long-wave spectrum. All real bodies emit and absorb less radiant energy than a blackbody at the same temperature and wavelength, for which their emittance is less than and varies with the wavelength in accord with Kirchhoff's law. In solids and liquids, emittance only slightly varies with the wavelength, while it strongly varies in gases. Atomic gases absorb (emit) radiant energy in distinct wavelength intervals that are called the spectral absorption lines. Molecular gases show absorption bands. Various types of surfaces have slightly different emissivities. Absorption and emission depend on the gases' atomic or molecular structure and the wavelength. Thus, each chemical element or combination of elements has its characteristic absorption and emission spectrum. Emission lines can result from transitions to the ground state or between excited states. According to Kirchhoff's law if radiation penetrating a gas can excite atoms (molecules), its energy will not be absorbed or emitted.

Atmospheric Radiation
This lecture covers the nomenclature and basic quantities used in meteorology to describe the atmospheric radiation processes. The basics of the interaction radiation-atmosphere and the radiative transfer are presented. The radiative transfer equation including the solution for a plane-parallel non-scattering atmosphere are discussed: the Beer-Bouguer-Lambert law, optically thick and optically thin.

Radiative Transfer

Depletion of the radiant intensity in traversing an the atmosphere. The monochromatic source function. The Beer-Bouguer-Lambert law,
and the solution of the Schuster-Schwarzschild equation. The optically thick and the optically thin.

Global Radiation Budget

The net radiation. The planetary albedo. Global shortwave radiation budget. The global long-wave or infrared radiation budget. Planet Earth has a variety of different surface types. They behave differently because of their various hydrological and radiative properties. The albedo and emittance depend on soil, vegetation type and coverage and snow/ice age and coverage. The following subsection exemplarily discusses the energy and water budget equations for an area partly covered by vegetation and a closed
snow-cover.

Natural Coordinates

Natural coordinates are useful for describing and understanding the kinematic and dynamic behavior of flows. Trajectories versus streamlines.

Kinematics of the Large-scale Flow

The absolute vorticity or Rossby Ertel vorticity in the inertial system and the relative velocity. The Coriolis parameter. The shear vorticity. The curvature velocity. The potential vorticity.

Navier-Stokes Equation

The local balance equation of momentum. Coriolis acceleration.The Coriolis force or Coriolis effect. Euler's equation of motion. Vorticity Equation.

Dynamics and Synoptic

In the lecture Dynamics and Synoptic, the basic laws for describing the kinematic and dynamic behavior of tropospheric flows are presented and discussed. The conservation equations for momentum (Newton's 2nd law), total mass (equation of continuity), dry air, water substances, trace constituents, and energy (1st principle of thermodynamics) are presented and explained, where inertial frames and moving frames rotating with the Earth are considered. Simplifications like the
hydrostatic and geostrophic approximations are related to scaling considerations (scale analysis). Balanced curved flows, streamlines and trajectories are explained as well. Circulation and vorticity principles are discussed to analyze rotational flows. This part includes, for instance, the balance equation for vorticity and the distinction between absolute and relative vorticity.Wave analysis is explained by examples like gravity waves and Rossby waves. Principles of Ekman's physics of the atmospheric boundary layer are presented to point out the effects of turbulent motion. The lecture also encompasses how principles of dynamics and kinetic as well as numerical weather prediction model results are used in weather forecasting.

Geostrophic Wind

The geostrophic approximation and the geostrophic wind. The technic for calculate the geostrophic wind.

Tropical Cyclones

Parameters are relevant for the genesis of tropical cyclones. Dynamics of Tropical Cyclones.

Vertical Velocity

Calculate the vertical scalar velocity in cyclone use pressures other levels.

Turbulent Motion

Properties are associated with turbulent flows. A model concept of turbulence. Reynolds averaging. The

Boussinesq approximation and it is related to Reynolds averaging. Reynolds stress tensor. Anelastic approximation. The closure problem of turbulence. Parameterize the eddy transport phenomena: the first-order closure.

Weather Maps

Weather maps are the result of either observations or NWP. In the following, we briefly discuss various commonly used weather maps. The task to study cyclonic activity: find the cyclone, determine the stage, track the pressure change in the center, determine the height of the baric formation at all stages, determine the position of the fronts.

Frontal Motions

Bjerknes' circulation theorem. Arctic, polar and mediterranean front, and jet stream. The transition zone. Conveyor belt theory. Migration of surface cyclones relative to Rossby Waves. Other kinds of depressions originate from thermal heat lows developing over inland continental areas in summer as well as dynamic or orographic depressions. Cold and warm fronts.

Anticyclones

Anticyclones characteristics is given. The section explains the mechanism of development anticyclones.

Climate and Climatology

This lecture is a brief introduction to climate and climatology in a sense as it is used in meteorology. It introduces the basic nomenclature used in climate studies and climatology. The lecture provides a brief introduction into basic climate statistics and climate analysis methods and discusses the general circulation in terms of examples of applications. Major large scale and mesoscale features are elucidated from a meteorological point of view as they are part of the regional
climate. Furthermore, a brief glimpse on the biogeophysical cycle is provided. Major challenges of climate and Earth system modeling as well as regional climate modeling are pointed out. The lecture also presents the Köppen-Geiger classification that is recently often applied for climate assessment and assessment of climate model simulations.

Regional Climate

In many places on Earth, the distance to large water surfaces, the elevation, topography of the landscape, the land-cover and/or land-use of the landscape strongly affect the regional climate. In various lectures, we already addressed some regional climate features as examples or applications, for instance, orographic lifting, radiation fog, radiative inversions or subsidence inversions. Realize that mesoscale phenomena are going hand in hand with favorable large scale forcing. This means in regional climate dynamics no general overall theory exists. Nevertheless, everything follows the physical laws discussed in previous lectures. Here we briefly present the physics behind the regional climate aspects that are overlain to the general circulation features discussed in the previous sections. For brevity, we restrict the discussion to regional climate aspects not covered in previous chapters.

Climate change

The lecture explains the mechanism of climate change. Exampels climate change is given. Climate change characteristics is showen.

The Final Test

The final control task of theoretical knowledge was tested.

Study of geospheres. Study of hydrosphere

Hydrology as a science. History of Hydrology. Physical and chemical properties of water. The global

hydrological cycle. Residence time. Catchments, Watersheds and Drainage Basins. Physical Characteristics of Watersheds. Runoff mechanisms. Overland flow. Subsurface flow. Baseflow. Channel flow. Measuring streamflow. Physical or geomorphological estimation techniques. Runoff in the context of water quality. Streamflow Forecasting. Hydrologic cycle of groundwaters. Groundwater occurrence. Aquifers. Groundwater flow. Groundwater contamination and protection. Hydrograph separation. The unit hydrograph. Flow duration curves. Flood frequency analysis. Water resource in a changing world.

1. Introduction

Hydrology as a science. History of Hydrology. Physical and chemical properties of water.

2. The hydrological cycle

The global hydrological cycle. The catchment hydrological cycle. The catchment or river basin. The water balance equation. Residence time.

3. Watersheds Geomorphology

Catchments, Watersheds and Drainage Basins. Types of Watersheds. Physical Characteristics of Watersheds. Channel Characteristics of Watersheds. Runoff and the Catchment. Basin Characteristics Affecting Runoff.

4. Surface water hydrology

Runoff mechanisms. Overland flow. Subsurface flow. Groundwater contribution to stormflow. Summary of storm runoff mechanisms. Baseflow. Channel flow. Measuring streamflow. Instantaneous streamflow measurement. Continuous streamflow measurement. Measuring hillslope runoff. Estimating streamflow. Physical or geomorphological estimation techniques. Dilution gauging. Floods. Influences on flood size. Runoff in the context of water quality. Rudimentary Precipitation-Runoff Relationships. Streamflow Frequency Analysis. Streamflow Forecasting.

5. Groundwater hydrology

Groundwater: a vital resource. Hydrologic cycle of groundwaters. Groundwater occurrence. Aquifers. Groundwater flow. Wells. Groundwater use. Groundwater quality. Groundwater contamination. Groundwater protection. Planning for the future.

6. Streamflow analysis

Hydrograph separation. The unit hydrograph. Flow duration curves. Flood frequency analysis. Limitations of frequency analysis.

7. Water resource in a changing world

Climate change. Change in land use. Groundwater depletion. Urbanization.

The final test

The final test contain theoretical questions which cover whole course topics.

Study of geospheres. Landscape science

1. Untroduction

Object and subject of research in landscape studies. The question of the relationship between Geography and Ecology. Social and economic significance of Landscape Science.

2. History and Current Situation of Landscape science

Historical review of landscape ideas and landscape-ecological ideas. Landscape science schools in Russia. The position of Landscape Science in the system of Earth’s sciences. Landscape science as a scientific direction in Physical Geography.

3. Concept of the Landscape

Geographic components. Landscape, geosystem, natural-territorial complex. Representation and image of the landscape. Components and characteristics of the landscape. Conditions for selecting a landscape. Interpretations of the term landscape.

4. Research Methods

Research methods in Landscape Science. Traditional and modern research methods. GIS technologies. Landscaping method. Typification and classification of landscapes.

5. Composition and Structure of the Landscape

Landscape components and landscape-forming factors. Geological basement, relief, climate, hydrological objects and the organic world of the landscape. Parts of the landscape. Vertical and horizontal structure of the landscape. Patterns. The boundaries of the landscape.

6. Dynamics and Functioning of the Landscape

Landscape moisture rotation. Biogenic turnover of substances. Abiotic migration of lithosphere matter. Energy of the landscape and the intensity of functioning. Variability, stability and dynamics of the landscape. Landscape development. Age and longevity of the landscape.

7. Concept of the Cultural Landscape

Stages of evolution of mankind and earthly nature. Reversible and irreversible anthropogenic changes in nature. Modern natural and anthropogenic landscapes. Socio-economic functions of landscapes. Classification of anthropogenic landscapes. Geotechnical systems. Ecological frame. Development of ideas about the cultural landscape. Modern cultural landscapes: structure, functioning, anthropogenic regulation.

8. Landscape Planing

Functional zoning of the territory. Green cities. National parks and natural parks. Landscape design. Landscape design

The Final Test

The final test is carried out in the last practical class. The test includes 30 questions on landscape science topics. The solution time is 60 minutes.

Study of geospheres. Study of biosphere

The biosphere is viewed as an integral system evolving and functioning under the influence of the activity of living matter.

The concept of the biosphere as an area of distribution of life

The section is devoted to the modern biosphere, its boundaries and integral parameters of living matter.

Introduction. The boundaries of the biosphere.

Unity and integrity of the biosphere. Methodological significance of the study of the biosphere for nature conservation. Significance in solving problems and developing methods of applied ecology. The place of the study of the biosphere in the system of natural sciences.
The boundaries of the modern biosphere. Physical and chemical parameters that determine the spread of life. The concept of "past biospheres".
Evolution of ideas about a single picture of the world. Russian cosmism. V.I.Vernadsky and the cosmological meaning of the study of the biosphere.

Living matter of the biosphere.

Definition of the living matter of the biosphere. Modern parameters of living matter: biomass and productivity of land and sea organisms, diversity of prokaryotes and eukaryotes, integral indicators of the biological cycle in the biosphere.
Types of matter in the biosphere: living, biogenic, bioinert, etc. Biogenic migration of chemical elements. Biogeochemical principles of V.I. Vernadsky. Global functions of living matter in the biosphere. Energy function: accumulation of solar energy during photosynthesis and chemosynthesis, pyramid of energy, increasing energy reserves in natural waters, soils, lithosphere. Concentration function of living matter: selective absorption of chemical elements, bioabsorption coefficients, biogenic minerals. Environment-forming function: change in mechanical, physical, chemical and parameters of the environment under the influence of living organisms and waste products. Destructive function: decomposition of organic and mineral substances by organisms. Transport function: active movement of substances by animals and plants.

Evolution of the biosphere

The section is devoted to the evolution of the biosphere; the evolution of species of living organisms is transferred to the environment, the evolution of the biosphere as a whole is underway.

The interaction of the evolution of species and the evolution of the biosphere according to V.I. Vernadsky

The origin of life and the biosphere. General ideas about the evolution of the biosphere. Geochemical treatment of species and speciation. Interaction between the evolution of living organisms and the evolution of the biosphere. Biosphere determination of the processes of macroevolution of life.
The main trends in the evolution of the biosphere according to V.I. Vernadsky. Changes in the biomass of living matter, an increase in the organization of the biosphere, the accumulation of energy in connection with the evolution of life and the biosphere. The value of living matter in the formation and stabilization of the spheres of the planet. The emergence and functioning of bioinert bodies. A new form of migration of chemical elements in the biosphere. The concept of biospheric adaptations.

Evolutionary changes in the integral characteristics of the biosphere

Modern ideas about changes in biomass and biological productivity of living matter in the course of evolution. Changes in energy reserves in the process of evolution and expansion of life. Energy accumulation in bio-inert and biogenic systems of the biosphere. The relationship between the energy structure of the biosphere and the processes of improving bioenergy systems. Changes in the information "fund" of the biosphere: increase in biological information, accumulation of information in bioinert and biogenic formations. The stages of development of the biological cycle of elements, the increase in its intensity in the course of the evolution of life and the biosphere. Conjugate evolution of abiotic and biotic components of the environment. Self-regulation of the biosphere and biosphere adaptations: cycles of biogenic elements, regulation of ocean chemistry, the system of trophic connections, soil cover functions, stability and self-regulation of ecosystems, etc.

Evolution of the planet's bioinert systems

The section discusses the main stages of changes in the flora and fauna of the Earth, as well as the influence of the evolution of life on the geospheres, on the formation of bioinert and biogenic matter.

Geochronology of the evolution of living organisms.

The sequence and duration of the main stages in the history of the biosphere, changes in the nature of fauna and flora.

Biological cycle as the main factor in the formation and evolution of the planet's geospheres.

Bioinert systems of the planet. The biological circulation of substances is the main factor in the emergence, complication, differentiation, and self-organization of bioinert bodies.

The influence of the evolution of living matter on the gas composition of the atmosphere. Hypotheses about the origin of the Earth's atmosphere, degassing of the mantle. The composition of the primary atmosphere, the participation of microorganisms in its transformation. The emergence of an oxygen-carbon biogeochemical cycle and the accumulation of free oxygen. The relationship between the dynamics of oxygen content and the progressive evolution of animals. Historical transformations of vegetation, atmosphere and climate as a single self-regulating process. The cyclical nature of the mass exchange of gases in the modern system: living matter - atmosphere. Relationship between the gas composition of the atmosphere and the thermal regime of the planet. Hypotheses about the origin of the hydrosphere. Historical geochemistry of the ocean. The role of living organisms in the formation of the chemical composition of the ocean in the Precambrian. Changes in ocean chemistry in the Phanerozoic. Bioinert nature of the modern ocean: the processes of formation and decomposition of living matter and their participation in the differentiation of the properties of the water column, in the formation of silts, in the migration of scattered elements. Zoning in the accumulation of biogenic sediments of the world ocean.
Evolution of sediment formation in relation to the evolution of life. Abiogenic stage of sedimentation. Stages of sediment formation in connection with the evolution of living matter. Direct and indirect influence of vital processes on sedimentation. Morphological, biochemical and geochemical evidence of the participation of living organisms in the formation of sedimentary rocks of the Precambrian.
The participation of living organisms in the formation of carbonate, siliceous sedimentary rocks, caustobiolites, phosphates, ferruginous, manganese and alumina rocks, salts, clastic and clayey sedimentary rocks, deposits of sulfur, uranium, polymetallic ores. Irreversible progressive evolution of the earth's crust and upper mantle, hypotheses about the interaction of matter and energy of the biosphere with the internal energy of the Earth, matter of deep origin.

Bioinert and biogenic systems of the biosphere

The emergence of living organisms on land, the accumulation of waste products, the formation of contrast in the geochemical environment. Surface waters and silts as bioinert systems; the role of plants and microorganisms in the formation of hydrochemical zoning of waters. Variety of silts; biogeochemical mechanisms of formation of gley, hydrogen sulfide, diatom and other silts. Relict silts. Bioinert nature of the weathering crust and aquifers of the lithosphere, the variety of their properties and connection with the processes of life and soil formation. Bioinert nature of soils: biogenic accumulation of chemical elements, the role of living organisms in the formation of the soil profile. Formation of primary soils. Relationship between soil formation and the evolution of higher plants and transformations of the biological cycle of substances. The main stages of soil evolution, the development of the main types of soil formation. Biogeochemical and energy patterns of ecosystem functioning. The main components of the biological cycle of chemical elements in terrestrial ecosystems. Biomass and annual production of vegetation as the most significant features of an ecosystem. Photosynthesis and chemosynthesis as sources of energy for vital processes. Energy transfer from autotrophs to consumers and reducers. The influence of vital processes on the inert components of the ecosystem.

The influence of the history of society on the history of nature

Changes in the natural environment and the development of human society.
The impact of ancient man on the ecosystems of the Earth: selective destruction of animals, pyrogenic influence, deforestation. The scale of the Cro-Magno influence on the nature of America, Australia, Tasmania. The forced transition of a person from an appropriating economic structure to a reproducing one. The ecological consequences of ancient agriculture and animal husbandry. Creation of the first artificial biocenoses. Improvement of the exploitation of natural resources in the conditions of agricultural culture. Gradual anthropogenic evolution of the planet's natural ecosystems. Man's alienation from nature, man's opposition to the natural world.
Environmental consequences of technogenesis.

The concept of technogenesis. Technogenic characteristics of the modern biosphere. Geochemical and geophysical consequences of technogenesis. Geochemical transformation of ecosystems, technogenic geochemical anomalies. Resistance of ecosystems to pollution. Ecosystems, War and the Military-Industrial Complex; ecocide - deliberate human impact on ecosystems for military purposes. The threat to the existence of life from nuclear energy: the consequences of radionuclide pollution, forecast of the destruction of the biosphere during a nuclear war.
The state of living matter in the modern biosphere. Decrease in biomass and productivity, destruction of habitats, decrease in biodiversity. Features of the evolution of living matter in the modern biosphere: mutagenic activity of the products of technogenesis, a directed increase in the diversity of individual groups of organisms,

Composition of the modern biosphere

The section is devoted to the chemical organization of the modern biosphere, the role of living organisms in the regulation of global cycles of chemical elements in the biosphere. The concepts of biosphere development are considered.

Biogeochemical cycles of the elements in the biosphere

The main regularities of biogenic, physicochemical, mechanical, technogenic migration of chemical elements. The global carbon cycle. Content and form of occurrence of carbon in the atmosphere and the world's oceans. Carbon content in organisms of land, ocean, pedosphere. Reserves and form of occurrence of carbon in the sedimentary shell and the earth's crust. Fractionation of carbon isotopes with living matter. The importance of photosynthesis and carbonate formation in the regulation of carbon dioxide concentration. Atmo- and hydrochemical carbon cycle and the influence of vital processes on it. Carbon cycle and biosphere climate. Technogenic input of carbon oxides into the atmosphere.
Global cycles of oxygen and hydrogen. Oxygen reserves and form in the atmosphere, hydrosphere and lithosphere. Photosynthesis and oxygen formation. Oxygen exchange between the atmosphere and the ocean. Biogenic and abiogenic mechanisms of hydrogen migration: degassing of the mantle, dissipation into space, binding in living and inert matter.
Global nitrogen cycle. Geological sources of nitrogen input into the atmosphere. Stocks and form of nitrogen in the earth's crust, atmosphere and oceans. Nitrogen content in living matter of land, ocean, pedosphere. Migration of nitrogen between the atmosphere, pedosphere, ocean, land waters, living matter. Participation of nitrogen in sedimentation. The role of microorganisms in the formation and fixation of nitrogen compounds: nitrogen fixation, ammonification, nitrification. Uptake of nitrogen by plants, animals, soil. Technogenic changes in global nitrogen cycles, the role of industrial fixation, fertilizers, legumes, wastewater.
Global phosphorus cycle. Content in the earth's crust, hydrosphere, land and ocean organisms, pedosphere matter. The role of weathering and geological processes in the entry of phosphorus into the biosphere. Participation in the biological cycle and continental runoff. Anthropogenic influence on the phosphorus cycle, the role of phosphorus fertilizers, wastewater.

Direction of development of the modern biosphere

The concept of the unity of man and nature according to V.I. Vernadsky, the doctrine of the noosphere. The problem of biodiversity conservation, disruption of global biogeochemical cycles of substances in the biosphere and their consequences. The concept of co-evolution of man and the biosphere. Analysis of alternative ways of possible evolution of the biosphere: stopping technical progress and returning to autotrophic mechanisms of existence, complete replacement of the biosphere with the technosphere, resettlement to other planets, etc.

The final test

Writing an essay "What is the main essence of the study of the biosphere?"

6. Методические указания для обучающихся по освоению дисциплины

Освоение дисциплины требует систематического изучения всех тем в той последовательности, в какой они указаны в рабочей программе.

Основными видами учебной работы являются аудиторные занятия. Их цель - расширить базовые знания обучающихся по осваиваемой дисциплине и систему теоретических ориентиров для последующего более глубокого освоения программного материала в ходе самостоятельной работы. Обучающемуся важно помнить, что контактная работа с преподавателем эффективно помогает ему овладеть программным материалом благодаря расстановке необходимых акцентов и удержанию внимания интонационными модуляциями голоса, а также подключением аудио-визуального механизма восприятия информации.

Самостоятельная работа преследует следующие цели:

– закрепление и совершенствование теоретических знаний, полученных на лекционных занятиях;

- формирование навыков подготовки текстовой составляющей информации учебного и научного назначения для размещения в различных информационных системах;

- совершенствование навыков поиска научных публикаций и образовательных ресурсов, размещенных в сети Интернет;

- самоконтроль освоения программного материала.

Обучающемуся необходимо помнить, что результаты самостоятельной работы контролируются преподавателем во время проведения мероприятий текущего контроля и учитываются при промежуточной аттестации.

Обучающимся с ОВЗ и инвалидов предоставляется возможность выбора форм проведения мероприятий текущего контроля, альтернативных формам, предусмотренным рабочей программой дисциплины. Предусматривается возможность увеличения в пределах 1 академического часа времени, отводимого на выполнение контрольных мероприятий.

Процедура оценивания результатов обучения инвалидов и лиц с ограниченными возможностями здоровья по дисциплине предусматривает предоставление информации в формах, адаптированных к ограничениям их здоровья и восприятия информации.

При проведении текущего контроля применяются оценочные средства, обеспечивающие передачу информации, от обучающегося к преподавателю, с учетом психофизиологических особенностей здоровья обучающихся.

7. Перечень учебно-методического обеспечения для самостоятельной работы обучающихся по дисциплине

При самостоятельной работе обучающимся следует использовать:

– конспекты лекций;

– литературу из перечня основной и дополнительной учебной литературы, необходимой для освоения дисциплины (модуля);

– текст лекций на электронных носителях;

– ресурсы информационно-телекоммуникационной сети "Интернет", необходимые для освоения дисциплины;

– лицензионное и свободно распространяемое программное обеспечение из перечня информационных технологий, используемых при осуществлении образовательного процесса по дисциплине;

– методические указания для обучающихся по освоению дисциплины.

8. Перечень основной и дополнительной учебной литературы

Основная:

1. Biosphere Reserves in Action:Case Studies of the American Experience.-Springfield,1995.-86.

2. V.I. Osipov, Biosphere and Environmental Safety / V.I. Osipov // Publisher Name: Springer, Cham, 2019. — 53 p. — ISBN 978-3-319-91259-2. — Текст : электронный // Электронно-библиотечная система SpringerLink : [сайт]. https://link.springer.com/book/10.1007/978-3-319-91259-2

3. Nicole Mölders. Lectures in Meteorology / Nicole Mölders. Gerhard Kramm // Publisher Name: Springer, Cham. - 2014. - 591 p. - ISBN 978-3-319-02144-7. [Электронный ресурс]. https://link.springer.com/book/10.1007%2F978-3-319-02144-7

4. Arup K. Sarma, Vijay P. Singh, Rajib K. Bhattacharjya, Suresh A. Kartha. Urban Ecology, Water Quality and Climate Change. Springer, Cham, 2018. Online ISBN 978-3-319-74494-0. Текст электронный. https://link.springer.com/book/10.1007/978-3-319-74494-0

Дополнительная:

1. Olivier Barrière. Coviability of Social and Ecological Systems: Reconnecting Mankind to the Biosphere in an Era of Global Change / Olivier Barrière, Mohamed Behnassi, Gilbert David, Vincent Douzal [и др.] // Publisher Name: Springer, Cham, 2019. — 729 p. — ISBN 978-3-319-78497-7. — Текст : электронный // Электронно-библиотечная система SpringerLink : [сайт]. https://link.springer.com/book/10.1007/978-3-319-78497-7

2. Kate Meyer. Planetary Accounting / Kate Meyer, Peter Newman // Publisher Name: Springer, Singapore. - 2020. - 278 p. - ISBN 978-981-15-1443-2. [Электронный ресурс]. https://link.springer.com/book/10.1007/978-981-15-1443-2

3. Robert C. Brears, "The Green Economy and the Water-Energy-Food Nexus", 2018, ISBN 978-1-137-58365-9. [Электронный ресурс]. https://link.springer.com/book/10.1057/978-1-137-58365-9

9. Перечень ресурсов сети Интернет, необходимых для освоения дисциплины

https://gmvo.skniivh.ru/ The system for state monitoring of water bodies
http://www.rivdis.sr.unh.edu/ The Global River Discharge Database (RivDIS v1.1)
https://whc.unesco.org UNECKO. Cuitural Landscape
https://www.britannica.com/science/biosphere Biosphere. David M. Gates

10. Перечень информационных технологий, используемых при осуществлении образовательного процесса по дисциплине

Образовательный процесс по дисциплине **Study of geospheres** предполагает использование следующего программного обеспечения и информационных справочных систем:
Presentation data (slides on the theoretical and practical classes); on-line access to the Electronic Library System (ELS); access to the electronic information and the university educational environment.
Internet services and electronic resources (search engines, e-mail, professional thematic chats and forums, audio and video conferencing systems, online encyclopedias, etc.)
Office "LibreOffice". Programs for demonstrations of video (VLC player).
Software for laptop: OS "Alt Education" (Contract № ДС 003–2020).

При освоении материала и выполнения заданий по дисциплине рекомендуется использование материалов, размещенных в Личных кабинетах обучающихся ЕТИС ПГНИУ (**student.psu.ru**).

При организации дистанционной работы и проведении занятий в режиме онлайн могут использоваться:

система видеоконференцсвязи на основе платформы BigBlueButton (https://bigbluebutton.org/).

система LMS Moodle (http://e-learn.psu.ru/), которая поддерживает возможность использования текстовых материалов и презентаций, аудио- и видеоконтент, а так же тесты, проверяемые задания, задания для совместной работы.

система тестирования Indigo (https://indigotech.ru/).

11. Описание материально-технической базы, необходимой для осуществления образовательного процесса по дисциплине

Lectures, seminars, practical exercises, class assessment, group (individual) consultations - a classroom equipped with presentation equipment (projector, screen, laptop) with software, chalk and/or marker board and/or computer class with required software.
Independent work – a classroom equipped with computers, connection to the Internet and access to the electronic information and educational environment of the PSU. Scienific library rooms of the Perm State University.

Помещения научной библиотеки ПГНИУ для обеспечения самостоятельной работы обучающихся:

1. Научно-библиографический отдел, корп.1, ауд. 142. Оборудован 3 персональными компьютера с доступом к локальной и глобальной компьютерным сетям.
2. Читальный зал гуманитарной литературы, корп. 2, ауд. 418. Оборудован 7 персональными компьютерами с доступом к локальной и глобальной компьютерным сетям.
3. Читальный зал естественной литературы, корп.6, ауд. 107а. Оборудован 5 персональными компьютерами с доступом к локальной и глобальной компьютерным сетям.
4. Отдел иностранной литературы, корп.2 ауд. 207. Оборудован 1 персональным компьютером с доступом к локальной и глобальной компьютерным сетям.
5. Библиотека юридического факультета, корп.9, ауд. 4. Оборудована 11 персональными компьютерами с доступом к локальной и глобальной компьютерным сетям.
6. Читальный зал географического факультета, корп.8, ауд. 419. Оборудован 6 персональными

компьютерами с доступом к локальной и глобальной компьютерным сетям.

Все компьютеры, установленные в помещениях научной библиотеки, оснащены следующим программным обеспечением:

Операционная система ALT Linux;

Офисный пакет Libreoffice.

Справочно-правовая система «КонсультантПлюс»

Фонды оценочных средств для аттестации по дисциплине
Study of geospheres

Планируемые результаты обучения по дисциплине для формирования компетенции. Индикаторы и критерии их оценивания

ОПК.5

владеть современными методами естественнонаучных исследований, анализа данных, проектирования

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
ОПК.5 владеть современными методами естественнонаучных исследований, анализа данных, проектирования	To know the modern methods of hydrological research, data analysis, design	**Неудовлетворител** Student doesn't know the modern methods of hydrological research. Unable to do basic data analysis and results interpretation with several mistakes. **Удовлетворительн** Student not well knows the modern methods of hydrological research. Able to do basic data analysis and results interpretation with several mistakes. **Хорошо** Student knows the modern methods of hydrological research. Able to do basic data analysis and results interpretation with few mistakes. **Отлично** Student knows the modern methods of hydrological research. Able to do basic data analysis and results interpretation.
ОПК.5 владеть современными методами естественнонаучных исследований, анализа данных, проектирования	Know the processes of functioning and dynamics of landscapes	**Неудовлетворител** Do not know the processes of functioning and dynamics of landscapes **Удовлетворительн** Knows the processes of functioning and dynamics of landscapes at a satisfactory level **Хорошо** Knows the basic processes of functioning and dynamics of landscapes **Отлично** Knows the processes of functioning and dynamics of landscapes at a level that allows solving complex professional problems
ОПК.5 владеть современными методами естественнонаучных	To know the modern biospheric processes, be able to analyze the role of biota in the stabilization of biospheric processes, to have	**Неудовлетворител** does not know the modern biospheric processes, does not know how to analyze the role of biota in the stabilization of biospheric processes, does

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
исследований, анализа данных, проектирования	skills of modern natural scientific research	**Неудовлетворител** not know the methodology of modern natural scientific research **Удовлетворительн** fragmentarily knows modern biosphere processes, fragmentarily knows how to analyze the role of biota in stabilizing biospheric processes, fragmentarily formed skills of modern natural scientific research **Хорошо** generally successful, but containing some gaps in knowledge of modern biosphere processes; generally successful, but containing some gaps in the ability to analyze the role of biota in the stabilization of biospheric processes; generally successful, but containing some gaps in the methodology of modern natural scientific research **Отлично** knows modern biospheric processes, is able to analyze the role of biota in stabilizing biospheric processes, skills of modern natural scientific research are formed

ОПК.3

знать основные теории, учения и концепции в профессиональной области

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
ОПК.3 знать основные теории, учения и концепции в профессиональной области	To know the basic concepts, terms and methods of landscape science	**Неудовлетворител** Do not know the basic concepts, terms and methods of landscape science **Удовлетворительн** Knows the concepts and terms of landscape science, do not know landscape research methods **Хорошо** Knows the concepts and terms of landscape science, makes mistakes in the application of the landscape research method **Отлично** Knows the basic concepts, terms and methods of landscape science, solves landscape problems
ОПК.3 знать основные теории, учения и концепции в профессиональной	Know the processes and phenomena occurring in the spheres of the Earth. Be able to analyze the role of the living	**Неудовлетворител** Does not know the processes and phenomena occurring in the spheres of the Earth. Doesn't know how to analyze the role of biota in the

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
области	matter in the formation and stabilization of the Earth's shells, biospheric processes.	**Неудовлетворител** formation and stabilization of the Earth's shells, biospheric processes. **Удовлетворительн** Partly knows the processes and phenomena occurring in the spheres of the Earth. It is difficult to analyze the role of biota in the formation and stabilization of the Earth's shells, biospheric processes. **Хорошо** Has a general idea of ??the processes and phenomena occurring in the spheres of the Earth. Makes minor mistakes when analyzing the role of living matter in the formation and stabilization of the Earth's shells, biospheric processes. **Отлично** Perfectly knows the processes and phenomena occurring in the spheres of the Earth. Knows how to analyze the role of living matter in the formation and stabilization of the Earth's shells, biospheric processes.

ОПК.8

знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	To know the theory of surface and groundwater hydrology.	**Неудовлетворител** Do not know the hydrological cycle, surface and groundwater hydrology. Not able to determine the river catchment border and to calculate the catchment area and river length. Can’t do hydrograph separation. **Удовлетворительн** Know the hydrological cycle, surface and groundwater hydrology. Not able to determine the river catchment border and to calculate the catchment area and river length. Can’t do hydrograph separation. **Хорошо** Know the hydrological cycle, surface and groundwater hydrology. Able to determine the river catchment border and to calculate the catchment area and river length. Can’t do hydrograph separation. **Отлично**

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
		Отлично Know the hydrological cycle, surface and groundwater hydrology. Able to determine the river catchment border and to calculate the catchment area and river length. Can do hydrograph separation.
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	To know the systemic properties of landscapes, be able to apply the landscape method in professional activities.	**Неудовлетворител** Do not know the systemic properties of landscapes, does not know the landscape method **Удовлетворительн** To know 2-3 systemic properties of landscapes; be able to apply the landscape method in professional activities. **Хорошо** To know basis systemic properties of landscapes; be able to apply the landscape method in professional activities. **Отлично** To know the systemic properties of landscapes; be able to apply the landscape method in professional activities.
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	To form basic knowledge, skills and competencies in the application of landscape science in the professional activities of an ecologist	**Неудовлетворител** Do not know the basic knowledge, skills and competence of the application of landscape science in the professional activities of an ecologist **Удовлетворительн** The basic knowledge, skills and competences of the application of landscape science in the professional activity of an ecologist have been formed at a satisfactory level **Хорошо** The basic knowledge, skills and competences of the application of landscape science in the professional activity of an ecologist for solving simple problems have been formed **Отлично** Basic knowledge, skills and competencies of the application of landscape science in the professional activity of an ecologist have been formed at a level that allows solving design problems
ОПК.8 знать основы учения об	To know the basic concepts and terms of the study of biosphere	**Неудовлетворител** Has a poor understanding of the modern

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
атмосфере, о гидросфере, о биосфере и ландшафтоведении		**Неудовлетворител** parameters and functions of living matter. Poorly represents the role of living matter in the formation and evolution of the planet's geospheres, bioinert and biogenic systems; does not know the sequence and duration of the main stages in the history of the biosphere. Has a poor understanding of the structure of the modern biosphere, global cycles of elements **Удовлетворительн** Has an understanding of the modern parameters and functions of living matter. Poorly represents the role of living matter in the formation and evolution of the planet's geospheres; knows in general terms the sequence and duration of the main stages in the history of the biosphere. Has a poor understanding of the structure of the modern biosphere, global cycles of elements **Хорошо** Has an understanding of the modern parameters and functions of living matter. In general terms, it represents the role of living matter in the formation and evolution of the planet's geospheres; knows the sequence and duration of the main stages in the history of the biosphere. Has a general understanding of the structure of the modern biosphere, global cycles of elements **Отлично** Knows modern parameters and functions of living matter. Has an understanding of the role of living matter in the formation and evolution of the planet's geospheres; knows the sequence and duration of the main stages in the history of the biosphere. Knows the structure of the modern biosphere, global cycles of elements
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	To know the basic knowledge about the atmosphere, processes and phenomena occurring in it. Be able to make the simplest calculations of meteorological values. Possess the terms of meteorology.	**Неудовлетворител** Knows some of the gases the atmospheric air. Knows what the relative humidity is. Knows what the air density is. It can convert the Pa to the hPa. **Удовлетворительн** Knows the composition of atmospheric air. Can calculate the relative humidity and the dewpoint temperature deficit. Knows the equation of state of moist air. Knows the dependence of

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
		Удовлетворительн atmospheric pressure on altitude. Knows the Booger equation. Knows the mechanism of formation of clouds and precipitation. **Хорошо** Knows and is able to calculate the specific gas constant of moist air. Knows all the characteristics of humidity. Knows the Booger equation and the Stefan-Boltzmann equation. Knows what the baric step and the vertical pressure gradient are. Can calculate evaporation from the surface of snow and water bodies. **Отлично** Knows and is able to calculate the specific gas constant of moist air. Can accurately keep records and present the estimated materials of the task. Knows the units of measurement of humidity characteristics. Knows barometric formulas and knows how to use them. Knows the structure of the atmosphere and baric objects. It can build an aerological diagram and detect temperature inversion. Has the basic knowledge about of temperature and atmospheric pressure. Can calculate the insolation at a known Sun height and transparency coefficient.

Оценочные средства текущего контроля и промежуточной аттестации

Схема доставки : Базовая

Вид мероприятия промежуточной аттестации : Экзамен
Способ проведения мероприятия промежуточной аттестации : Оценка по дисциплине в рамках промежуточной аттестации определяется на основе баллов, набранных обучающимся на контрольных мероприятиях, проводимых в течение учебного периода.
Максимальное количество баллов : 100

Конвертация баллов в отметки

«отлично» - от 81 до 100
«хорошо» - от 61 до 80
«удовлетворительно» - от 50 до 60
«неудовлетворительно» / «незачтено» менее 50 балла

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Equation of State **Письменное контрольное мероприятие**	Be able to calculate the density values of dry and wet air under given conditions. Know the units of measurement of air density. Know the physically sound accuracy of the air density calculation. Ability to record air density calculations. Ability to accurately record decisions. Ability to calculate air density values without errors. Be able to search for information on the Internet and draw up charts.
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Hydrostatic Equation **Письменное контрольное мероприятие**	The ability to correctly calculate atmospheric pressure at known values of air temperature, humidity and elevation difference in the layer. Be able to accurately keep records of the decision. Knowledge of the units of atmospheric pressure measurement and the correction for bringing the pressure to sea level. Knowledge of the practical accuracy of the calculation of atmospheric pressure and the correction for the reduction of pressure to sea level.

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Barometric Pressure Adjusted to Sea Level **Письменное контрольное мероприятие**	The ability to correctly calculate atmospheric pressure at known values of air temperature, humidity and elevation difference in the layer. Be able to accurately keep records of the decision. Knowledge of the units of atmospheric pressure measurement and the correction for bringing the pressure to sea level. Knowledge of the practical accuracy of the calculation of atmospheric pressure and the correction for the reduction of pressure to sea level.
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Thermodynamic Diagrams. Stratification and Stability **Письменное контрольное мероприятие**	The temperature stratification curve. The dewpoint temperature stratification curve. The level of condensation. Student determines the position of the inversion. Student calculates the potential temperature of the air particle at an altitude of 800 hPa. Student calculates the pseudopotential temperature.
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Nucleation of Liquid Droplets **Письменное контрольное мероприятие**	Calculate the saturation relative humidity.
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Deposition and Sublimation **Письменное контрольное мероприятие**	Be able to calculate the mass of deposited moisture per drop, crystal, and flat surface of water.
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Raindrop Breakup **Письменное контрольное мероприятие**	Determine the maximum stable radius for a drop.
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Radiative Transfer **Письменное контрольное мероприятие**	The ability to correctly calculate the insolation and the turbidity factor. Be able to accurately keep records of the decision. Knowledge of the units of measurement of insolation. Knowledge of the practical accuracy of the calculation of insolation and turbidity factor.

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Global Radiation Budget **Письменное контрольное мероприятие**	Ability to determine the short-wave radiation balance. Ability to determine the long-wave radiation balance. Ability to calculate the total radiation balance.
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Geostrophic Wind **Письменное контрольное мероприятие**	Ability to calculate geostrophic wind
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Vertical Velocity **Письменное контрольное мероприятие**	Ability to calculate the vertical speed in a cyclone.
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Weather Maps **Письменное контрольное мероприятие**	Student could aible to find the cyclone, determine the stage, track the pressure change in the center, determine the height of the baric formation at all stages, determine the position of the fronts.
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Regional Climate **Письменное контрольное мероприятие**	Determine the climate of a site in the Earth.
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	The Final Test **Итоговое контрольное мероприятие**	Knowledge of the terms and theory of meteorology. For each correct answer to one of the 35 test questions – 1 point. In total, a maximum of 35 points for correct answers to all test questions.

Спецификация мероприятий текущего контроля

Equation of State

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
Graphs of the daily course of temperature, density of dry and moist air, atmospheric pressure and mass fraction of water vapor for the city specified in the task are plotted, the values are calculated correctly, the coordinate axes are signed correctly, the graphs are signed correctly, the date for which the graphs are plotted is specified	1
All values of humidity characteristics are calculated: partial pressure, absolute humidity, specific humidity (mass fraction of water vapor), mixture ratio, dew point deficit, saturation deficit.	1
The units of measurement for all six obtained humidity characteristics are indicated.	1

The solution and the answer are presented without blemishes and strikethrough.	1
All six values are specified with the required level of accuracy.	1

Hydrostatic Equation

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
The pressure gradient values must be calculated correctly	1
The problem is solved using the baric stage	1
The solution and the answer are presented without blemishes and strikethrough	1
The units of measurement specified in the response are correct	1
The problem with the use of a vertical pressure gradient is solved	1

Barometric Pressure Adjusted to Sea Level

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
Correctly find the correction for bringing the pressure to sea level	1
Correctly calculate with an error not exceeding 1% the pressure at the top of the mountain	1
The values are calculated with the required level of accuracy.	1
The units of measurement specified in the response are correct	1
The solution and the answer are presented without blots and strikethrough	1

Thermodynamic Diagrams. Stratification and Stability

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
The level of condensation is correctly determined and marked on the aerological diagram.	1
The inversion position is correctly defined and marked.	1
The temperature stratification curve is correctly constructed.	1
The pseudopotential temperature of the air particle at an altitude of 800 hPa is correctly calculated.	1
The potential temperature of the air particle at an altitude of 800 hPa is correctly calculated.	1

Nucleation of Liquid Droplets

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
The saturation relative humidity RH are calculated correctly.	2
The calculated values in the response are specified with the required level of accuracy.	1
The solution and the answer are presented without blemishes and strikethrough	1
The units of measurement are specified correctly in the responses.	1

Deposition and Sublimation

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
Correctly calculate the mass of deposited moisture per drop, crystal, and flat surface of water.	2
The calculated values in the response are specified with the required level of accuracy.	1
The solution and the answer are presented without blemishes and strikethrough	1
The units of measurement are specified correctly in the responses.	1

Raindrop Breakup

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
Correctly determine the maximum stable radius for a drop	2
The calculated values in the response are specified with the required level of accuracy.	1
The solution and the answer are presented without blemishes and strikethrough	1
The units of measurement are specified correctly in the responses.	1

Radiative Transfer

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
The turbidity factor is calculated correctly	1

The direct radiation to the horizontal surface (insolation) is correctly calculated)	1
The solution and the answer are presented without blemishes.	1
The calculated values in the response are specified with the required level of accuracy	1
The units of measurement are specified correctly in the response	1

Global Radiation Budget

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
The values of the short-wave radiation balance are calculated correctly	1
The long wave radiation balance values are calculated correctly	1
The solution and the answer are presented without blemishes	1
The values of the total radiation balance are calculated correctly	1
The calculated values are specified with the required level of accuracy	.5
The units of measurement are specified correctly in the response	.5

Geostrophic Wind

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
The value of the geostrophic wind is correctly determined	2
The calculated values in the response are specified with the required level of accuracy.	1
The solution and the answer are presented without blemishes	1
The units of measurement are specified correctly in the responses.	1

Vertical Velocity

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
The vertical velocity is calculated correctly	2
The calculated values in the response are specified with the required level of accuracy.	1
The solution and the answer are presented without blemishes.	1
The units of measurement are specified correctly in the responses.	1

Weather Maps

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
Find the cyclones	1
Determine the stages	1
Determine the position of the fronts	1
Determine the height of the baric formation at all stages	1
Determine track the pressure change in the center	1

Regional Climate

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы самостоятельной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **5**
Проходной балл: **2.5**

Показатели оценивания	Баллы
Tundra climates is correctly determined	1
Tropical rainforest climate is correctly determined	1
Subarctic climate is correctly determined	1
The humid subtropical climate is correctly determined	1
The tropical monsoon climate is correctly determined	1

The Final Test

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **35**
Проходной балл: **17**

Показатели оценивания	Баллы
For each correct answer to one of the 35 test questions – 1 point. In total, a maximum of 35 points for correct answers to all test questions.	35

Вид мероприятия промежуточной аттестации : Зачет
Способ проведения мероприятия промежуточной аттестации : Оценка по дисциплине в рамках промежуточной аттестации определяется на основе баллов, набранных обучающимся на контрольных мероприятиях, проводимых в течение учебного периода.
Максимальное количество баллов : 100

Конвертация баллов в отметки

«отлично» - от 81 до 100

«хорошо» - от 61 до 80
«удовлетворительно» - от 50 до 60
«неудовлетворительно» / «незачтено» менее 50 балла

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	5. Groundwater hydrology **Защищаемое контрольное мероприятие**	The basic concepts of watersheds geomorphology and surface water hydrology.
ОПК.5 владеть современными методами естественнонаучных исследований, анализа данных, проектирования	7. Water resource in a changing world **Защищаемое контрольное мероприятие**	The concepts of the groundwater hydrology and streamflow analysis.
ОПК.5 владеть современными методами естественнонаучных исследований, анализа данных, проектирования **ОПК.8** знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	The final test **Итоговое контрольное мероприятие**	To know the hydrological cycle, surface and groundwater hydrology. Be able to determine the river catchment border and to calculate the catchment area and river length.To do hydrograph separation.

Спецификация мероприятий текущего контроля

5. Groundwater hydrology

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **30**
Проходной балл: **15**

Показатели оценивания	Баллы
Student knows well the basic concepts of watersheds geomorphology and surface water hydrology. Able to answer any questions.	30
Student knows part of the basic concepts of watersheds geomorphology and surface water hydrology. Able to answer several questions.	20
Student knows few topics of watersheds geomorphology and surface water hydrology. Able to answer on minimum questions.	15

7. Water resource in a changing world

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **30**
Проходной балл: **15**

Показатели оценивания	Баллы
Student knows well runoff mechanisms, overland flow, subsurface flow, groundwater contribution to stormflow, summary of storm runoff mechanisms. As well as knows theory of streamflow measuring, instantaneous streamflow measurement, continuous streamflow measurement and estimating streamflow. Student can describe precipitation-runoff relationships and perform streamflow frequency analysis.	30
Student knows well runoff mechanisms, overland flow, subsurface flow, groundwater contribution to stormflow, summary of storm runoff mechanisms. As well as knows theory of streamflow measuring, instantaneous streamflow measurement, continuous streamflow measurement and estimating streamflow. Student can't describe well precipitation-runoff relationships and perform streamflow frequency analysis.	20
Student knows well runoff mechanisms, overland flow, subsurface flow, groundwater contribution to stormflow, summary of storm runoff mechanisms. As well as knows not well theory of streamflow measuring, instantaneous streamflow measurement, continuous streamflow measurement and estimating streamflow. Student can't describe well precipitation-runoff relationships and perform streamflow frequency analysis.	15
Student do not know well runoff mechanisms, overland flow, subsurface flow, groundwater contribution to stormflow, summary of storm runoff mechanisms. As well as knows not well theory of streamflow measuring, instantaneous streamflow measurement, continuous streamflow measurement and estimating streamflow. Student can't describe well precipitation-runoff relationships and perform streamflow frequency analysis.	10

The final test

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **40**
Проходной балл: **20**

Показатели оценивания	Баллы
Student can describe the hydrological cycle, surface and groundwater hydrology. Able to determine the river catchment border and to calculate the catchment area and river length. Student can do hydrograph separation.	40
Student can describe the hydrological cycle, surface and groundwater hydrology. Able to determine the river catchment border and to calculate the catchment area and river length. Student can't do hydrograph separation.	30
Student can describe the hydrological cycle, surface and groundwater hydrology. Student not able to determine the river catchment border and to calculate the catchment area and river length. Student can't do hydrograph separation.	20
Student can't describe the hydrological cycle, surface and groundwater hydrology. Student not able to determine the river catchment border and to calculate the catchment area and river length. Student can't do hydrograph separation.	10

Вид мероприятия промежуточной аттестации : Зачет
Способ проведения мероприятия промежуточной аттестации : Оценка по дисциплине в рамках промежуточной аттестации определяется на основе баллов, набранных обучающимся на контрольных мероприятиях, проводимых в течение учебного периода.

Максимальное количество баллов : 100

Конвертация баллов в отметки

«отлично» - от 81 до 100
«хорошо» - от 61 до 80
«удовлетворительно» - от 48 до 60
«неудовлетворительно» / «незачтено» менее 48 балла

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
ОПК.3 знать основные теории, учения и концепции в профессиональной области	3. Concept of the Landscape **Защищаемое контрольное мероприятие**	The basic concepts, terms and methods of landscape science
ОПК.5 владеть современными методами естественнонаучных исследований, анализа данных, проектирования	6. Dynamics and Functioning of the Landscape **Письменное контрольное мероприятие**	The processes of functioning and dynamics of landscapes
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	8. Landscape Planing **Защищаемое контрольное мероприятие**	The systemic properties of landscapes and the landscape method in professional activities
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	The Final Test **Итоговое контрольное мероприятие**	Basic knowledge, skills and competencies in the application of landscape science in the professional activities of an ecologist

Спецификация мероприятий текущего контроля

3. Concept of the Landscape

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **20**
Проходной балл: **9**

Показатели оценивания	Баллы
Practical work was done according to the algorithm. The student answered all the questions.	20
Practical work was done according to the algorithm. The student was unable to answer several questions.	9

6. Dynamics and Functioning of the Landscape

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **20**
Проходной балл: **10**

Показатели оценивания	Баллы
Practical work was done according to the algorithm. The student answered all the questions.	20
Practical work was done according to the algorithm. The student was unable to answer several questions.	10

8. Landscape Planing

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **30**
Проходной балл: **15**

Показатели оценивания	Баллы
Practical work was done according to the algorithm. The student answered all the questions.	30
Practical work was done according to the algorithm. The student was unable to answer several questions.	15

The Final Test

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **30**
Проходной балл: **14**

Показатели оценивания	Баллы
The final testing. The test contains 30 questions (1 correct answer – 1 points). The right answers to all tasks of the test are given.	30
The correct answers to 20 test tasks and more.	20
The correct answers to 14 tasks of the test.	14

Вид мероприятия промежуточной аттестации : Экзамен
Способ проведения мероприятия промежуточной аттестации : Оценка по дисциплине в рамках промежуточной аттестации определяется на основе баллов, набранных обучающимся на контрольных мероприятиях, проводимых в течение учебного периода.
Максимальное количество баллов : 100

Конвертация баллов в отметки

«отлично» - от 81 до 100
«хорошо» - от 61 до 80
«удовлетворительно» - от 47 до 60
«неудовлетворительно» / «незачтено» менее 47 балла

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Living matter of the biosphere. **Письменное контрольное мероприятие**	Statement and global functions of living matter in the biosphere
ОПК.8 знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Evolutionary changes in the integral characteristics of the biosphere **Письменное контрольное мероприятие**	Evolutionary changes in the integral characteristics of the biosphere
ОПК.3 знать основные теории, учения и концепции в профессиональной области **ОПК.8** знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	Bioinert and biogenic systems of the biosphere **Защищаемое контрольное мероприятие**	The functioning of bioinert and the formation of biogenic systems
ОПК.3 знать основные теории, учения и концепции в профессиональной области **ОПК.5** владеть современными методами естественнонаучных исследований, анализа данных, проектирования **ОПК.8** знать основы учения об атмосфере, о гидросфере, о биосфере и ландшафтоведении	The final test **Итоговое контрольное мероприятие**	Biogenic mechanisms of biosphere functioning

Спецификация мероприятий текущего контроля

Living matter of the biosphere.

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **20**
Проходной балл: **10**

Показатели оценивания	Баллы
is able to systematically assess the state and role of global functions of living matter in the biosphere	20
describes the state and global functions of living matter in the biosphere, but makes some	15

mistakes in explaining the role of these functions in biospheric phenomena and processes	
describes the state and global functions of living matter in the biosphere, but there is no understanding of the essence of the manifestation of these functions in biospheric phenomena and processes	10

Evolutionary changes in the integral characteristics of the biosphere

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **25**
Проходной балл: **12**

Показатели оценивания	Баллы
Knows the problem of changing the biomass and productivity of the biosphere, is able to describe the change in the energy of the biosphere in connection with the evolution of living organisms, is able to explain the accumulation of information in the course of the evolution of life and the biosphere, knows the main stages of the evolution of the biological cycle, has knowledge of the mechanisms and significance of the processes of self-regulation of the biosphere	25
Knows the problem of changes in biomass and productivity of the biosphere, fragmentarily knows how to describe the change in the energy of the biosphere in connection with the evolution of living organisms, fragmentarily knows how to explain the accumulation of information in the course of the evolution of life and the biosphere, fragmentarily knows the main stages of the evolution of the biological cycle, fragmentarily owns knowledge about the mechanisms and significance of processes self-regulation of the biosphere	17
Knows the problem of changing the biomass and productivity of the biosphere, is able to describe the change in the energy of the biosphere in connection with the evolution of living organisms, is able to explain the accumulation of information during the evolution of life and the biosphere, knows the main stages of the evolution of the biological cycle, has knowledge of the mechanisms and significance of self-regulation processes in the biosphere; however, makes some mistakes and inaccuracies in the evolutionary changes in the integral characteristics of the biosphere	12

Bioinert and biogenic systems of the biosphere

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **25**
Проходной балл: **12**

Показатели оценивания	Баллы
Knows about the change of flora and fauna in the evolution of the biosphere, is able to assess the influence of the evolution of living matter on the gas composition of the atmosphere; is able to assess the influence of the evolution of living matter on the formation of the chemistry of the world ocean, is able to assess the influence of the evolution of living matter on the process of sedimentation; knows how to assess the role of living matter in the formation of bioinert land systems; knows how to assess the role of living matter in the formation of sedimentary rocks	25

Knows in general terms about the change of flora and fauna in the evolution of the biosphere, is able to superficially assess the influence of the evolution of living matter on the gas composition of the atmosphere, on the formation of the chemistry of the world ocean, on the process of sedimentation; generally represents the role of living matter in the formation of bioinert systems of land and sedimentary rocks; however, when describing the role of living matter in the biosphere. Makes some mistakes and inaccuracies	17
Knows fragmentarily about the change of flora and fauna in the evolution of the biosphere, it is difficult to assess the influence of the evolution of living matter on the gas composition of the atmosphere, on the formation of the chemistry of the world ocean, on the process of sedimentation; weakly represents the role of living matter in the formation of bioinert systems of land and sedimentary rocks	11

The final test

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**
Условия проведения мероприятия: **в часы аудиторной работы**
Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **30**
Проходной балл: **13**

Показатели оценивания	**Баллы**
Knows how to characterize the biosphere as an integral shell of the Earth; understands the relationship between the evolution of life and the biosphere; knows how to substantiate the leading role of living matter in the formation of geospheres, in the formation of bioinert and biogenic matter; understands the geological role of humanity; understands the importance of the doctrine of the biosphere as a general scientific basis for nature protection.	30
Knows how to characterize the biosphere as an integral shell of the Earth; generally successful, but containing some gaps, the ability to substantiate the leading role of living matter in the formation of geospheres, in the formation of bioinert and biogenic matter; understands the geological role of mankind, understands the importance of the study of biosphere as a general scientific basis for nature protection.	21
Has an understanding in general of the biosphere as a habitat for living organisms, fragmentarily substantiates the leading role of living matter in the formation of geospheres, in the formation of bioinert and biogenic matter; fragmentarily understands the geological role of humanity; generally understands the importance of the study of biosphere as a general scientific basis for nature protection.	13