APPROVED
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Protocol № 11 from 23.05.2025 y.

Entrance Examination Program for Applicants to Doctoral Studies in the Educational Program Group D086 – "METEOROLOGY"

I. General Provisions

1. This program is developed in accordance with the Order of the Minister of Education and Science of the Republic of Kazakhstan dated October 31, 2018, No. 600 "On the Approval of Standard Rules for Admission to Education in Organizations Implementing Educational Programs of Higher and Postgraduate Education" (hereinafter referred to as the Standard Rules).

2.The doctoral entrance examination consists of an interview, writing an essay, and a subject-specific examination.

Component	Points
1. Interview	30
2. Essay	20
3. Examination in the profile of the educational program group	50
Total / Passing score	100 / 75

3. The duration of the entrance examination is 3 hours and 10 minutes, during which the applicant writes an essay and answers questions from an electronic examination ticket. The interview is conducted at the university prior to the entrance exam.

II. Procedure for the Entrance Examination

1. Applicants for the doctoral program in the educational program group "D086 – METEOROLOGY" are required to write a problem-based or thematic essay. The essay must be at least 250 words in length.

The purpose of the essay is to assess the applicant's level of analytical and creative skills, demonstrated through their ability to construct a personal argument based on theoretical knowledge, social, and personal experience.

Types of essays:

− A motivational essay explaining the driving reasons behind the applicant's interest in research;

− A scientific-analytical essay justifying the relevance and methodology of the proposed research;
− A problem-based/thematic essay reflecting various aspects of scientific knowledge in the subject area.

2. The electronic examination ticket consists of 3 questions.

Topics for preparation for the exam in the profile of the educational program group:

Subject: Physical Meteorology

Topic 1. General information about the atmosphere

1.1. Composition of the atmosphere
1.2. Equation of state for atmospheric air
1.3. Structure of the atmosphere

Topic 2. Atmospheric statics

2.1. Basic equation of statics
2.2. Barometric formulas

Topic 3. Atmospheric radiation regime

3.1. Solar radiation
3.2. Attenuation of solar radiation
3.3. Laws of radiation
3.4. Emission of the Earth and atmosphere
3.5. Radiation balance of the Earth's surface, the atmosphere, and the Earth-atmosphere system

Topic 4. Soil thermal regime

4.1. Thermal-physical properties of soil
4.2. Heating and cooling processes of the soil
4.3. Propagation of temperature fluctuations into the soil. Fourier’s laws
4.4. Influence of natural cover on soil temperature

Topic 5. Thermodynamics of the atmosphere

5.1. First law of thermodynamics
5.2. Adiabatic process
5.3. Stability criteria of the atmosphere by the parcel method
5.4. Moist adiabatic processes
5.5. Stratification of the atmosphere relative to moist and dry adiabatic motion
5.6. Thermodynamic diagrams

Topic 6. Thermal state of the atmosphere

6.1. Turbulent state of the atmosphere. Surface layer
6.2. Diurnal air temperature cycle in the boundary layer
6.3. Interaction of the atmosphere with the underlying surface
6.4. Thermal regime of the troposphere, stratosphere, and mesosphere
6.5. Temperature inversions in the atmosphere

6.6. Thermal balance of the underlying surface
6.7. Trace gases and impurities in the atmosphere. Ozone

Topic 7. Air humidity

7.1. Water vapor transport equation in a turbulent atmosphere
7.2. Vertical distribution of humidity characteristics
7.3. Humidity distribution in the troposphere and stratosphere
7.4. Evaporation and evaporability

Topic 8. Clouds, fogs, and precipitation

8.1. General conditions for phase transitions of water in the atmosphere
8.2. Dependence of latent heat and saturated vapor pressure on temperature. Phase equilibrium diagram
8.3. Physical conditions and classification of fogs
8.4. Classification of clouds (morphological and genetic)
8.5. Atmospheric processes leading to cloud formation
8.6. Cloud structure (main levels). Microphysical characteristics of clouds
8.7. Evolution of cloud forms. Transitional forms
8.8. Stratospheric and mesospheric clouds
8.9. Frontal cloud systems
8.10. Precipitation formation and classification
8.11. Surface condensation
8.12. Condensation nuclei and their classification

Topic 9. Fundamentals of atmospheric dynamics

9.1. Forces acting in the atmosphere
9.2. Free atmosphere motion
9.3. Features of air movement in the atmospheric boundary layer
9.4. Local winds

Topic 10. Optical and electrical phenomena in the atmosphere

10.1. Optical phenomena caused by light scattering in the atmosphere
10.2. Optical phenomena caused by light refraction in the atmosphere
10.3. Optical phenomena due to refraction and reflection in cloud droplets and ice crystals
10.4. Optical phenomena caused by diffraction of light in clouds and fog
10.5. Atmospheric ionization
10.6. Ionosphere
10.7. Auroras and their classification

Discipline: Climatology

Topic 1. Main Factors of Climate Formation

1.1. Concept of climate
1.2. Climate system and its characteristics
1.3. Astronomical and geophysical factors of climate formation
1.4. Energy-related factors of climate formation
1.5. Distribution of solar radiation at the top of the atmosphere. Solar climate
1.6. Incoming solar radiation at the Earth's surface. Radiation balance of the Earth's

surface
1.7. Heat balance of the Earth's surface and the Earth–atmosphere system
1.8. Main patterns of geographic distribution and temporal variability of components of the radiation and heat balance of the Earth's surface
1.9. Active surface and its impact on climate formation
1.10. Influence of snow and ice cover on climate
1.11. Influence of the land-sea distribution on climate
1.12. Volcanic eruptions as a climate-forming factor

Topic 2. Circulation Factors of Climate Formation

2.1. Main features and properties of general atmospheric circulation
2.2. Characteristics of prevailing zonal circulation in the troposphere and stratosphere
2.3. Quasi-biennial oscillation and its nature
2.4. Cyclonic activity, pressure fields, and near-surface air circulation
2.5. Atmospheric circulation in the tropical zone: trade winds, Intertropical Convergence Zone, tropical cyclones
2.6. Monsoon circulation. Monsoons in tropical and extratropical latitudes
2.7. Planetary long waves (Rossby waves)
2.8. Recurrence of cyclones and anticyclones. Atmospheric action centers
2.9. Climatological fronts

Topic 3. General Ocean Circulation and Its Impact on Climate

3.1. Main ocean currents of the World Ocean and heat transport by ocean currents
3.2. El Niño and La Niña phenomena
3.3. Large-scale oscillations of water temperature in the World Ocean
3.4. North Atlantic and North Pacific oscillations and their role in climate formation
3.5. Arctic Oscillation and its influence on climate
3.6. Energy-active zones of the ocean

Topic 4. Temperature Field and Its Determining Factors

4.1. Geographic distribution and temporal variability of air temperature on Earth
4.2. Zonal temperature field in the lower atmosphere and at higher altitudes
4.3. Influence of thermal properties of continents and oceans on the temperature field
4.4. Oceanic and continental climate types
4.5. Continentality indices

Topic 5. Humidity and Cloudiness Fields and Their Role in Climate Formation

5.1. Main characteristics of the humidity field
5.2. Spatial and temporal distribution of humidity and precipitation characteristics
5.3. Joint influence of thermal and humidity regimes on climate. Droughts
5.4. Horizontal moisture transport in the atmosphere
5.5. Atmospheric moisture content. Moisture circulation in the atmosphere
5.6. Moisture balance on continents. Semi-empirical theory of moisture circulation

Topic 6. Climate Classification

6.1. Purpose of climate classifications for scientific and applied tasks

6.2. Difference between "classification" and "regionalization"
6.3. Early climate classifications
6.4. Köppen’s classification: strengths and weaknesses
6.5. Landscape-botanical classification by L.S. Berg
6.6. Genetic classifications (by B.P. Alisov, M.I. Budyko, and A.A. Grigoriev)
6.7. Botanical classifications of climate
6.8. Distribution of major climate characteristics in various parts of the globe based on classifications

Topic 7. Meso- and Microclimate

7.1. Concept of meso- and microclimate
7.2. Microclimate as a phenomenon of the near-surface atmospheric layer
7.3. Influence of relief, vegetation, water bodies, and buildings on microclimate
7.4. Urban mesoclimate
7.5. Influence of large cities on the distribution of temperature, cloudiness, and precipitation

Topic 8. Climate Changes and Variability

8.1. Climate variability, changes, and fluctuations
8.2. Current natural and anthropogenic climate changes
8.3. Changes in the nature of the Earth’s active surface: urbanization, aerosol, gas, and thermal pollution
8.4. Change in CO_2 and other trace gas concentrations due to human activity
8.5. General circulation models of the atmosphere and ocean
8.6. Current scenarios of future climate change
8.7. Global and regional contemporary climate changes

Discipline: Features of General Atmospheric Circulation

Topic 1. Types and Indices of Atmospheric Circulation

1.1. Circulation types by B.L. Dzerdzeevsky
1.2. Classification of atmospheric processes by G.Ya. Vangengeim and A.A. Girs
1.3. Synoptic process types by M.Kh. Baidal
1.4. Forms of atmospheric circulation by A.L. Katz
1.5. Rossby’s atmospheric circulation indices
1.6. General circulation index by E.N. Blinova
1.7. General circulation index by A.L. Katz

Topic 2. Main Patterns of General Atmospheric Circulation

2.1. Use of generalized indicators of general atmospheric circulation in forecast schemes
2.2. Quantitative indices of circulation intensity (Rossby, Blinova, Katz) as predictors in forecasting
2.3. Polar vortex: seasonal characteristics. Use of spring and autumn circulation transitions in stratosphere to forecast hazardous weather events
2.4. General atmospheric circulation and solar activity

2.5. Nature of solar-terrestrial interactions. Heliophysical influences on Earth's pressure field
2.6. Connection between extreme weather conditions and solar activity. Droughts and harsh winters in the 11-year solar cycle. Geomagnetic disturbances as indicators of droughts and severe winters
2.7. Oscillations of Earth's rotation parameters (angular velocity, nutation) and their influence on atmospheric circulation and weather
2.8. El Niño phenomenon and its role in forming extreme weather conditions on the continent

Topic 3. Accounting for Underlying Surface Influence in Long-Term Weather Forecasting

3.1. Use of surface characteristics in long-term weather forecasts: synoptic-climatic and statistical studies
3.2. Ocean-atmosphere interaction. Types of interaction: small-scale and large-scale, first and second kind heat engines (according to Shuleikin)
3.3. Large-scale ocean-atmosphere interaction. Duvanin model
3.4. Role of the North Atlantic in weather formation in Kazakhstan
3.5. Role of the Pacific Ocean in weather formation in Kazakhstan
3.6. Influence of Arctic sea ice on continental weather formation
3.7. General circulation models of the atmosphere and ocean

Discipline: Forecasting Natural Disasters

Topic 1. General Scientific Problems of Forecasting

1.1. Methodological problems in forecasting natural disasters
1.2. Forecast and hypothesis: their essence
1.3. Theoretical aspects of forecasting

Topic 2. Forecasting of Natural Disasters

2.1. Medical-demographic assessment of the territory
2.2. Possibilities of deterministic forecasting of hazardous natural phenomena
2.3. Analysis of methods for forecasting dangerous convective phenomena
2.4. Methods of probabilistic forecasting of hazardous natural phenomena
2.5. Interpretation of results of synoptic-statistical methods for forecasting dangerous weather events

Topic 3. Natural Disasters and Emergencies

3.1. Classification of emergencies
3.2. Quantitative assessment of disaster scale
3.3. Geographic component of the potential loss index for hazardous natural phenomena
3.4. Determination of average consumer losses based on predicted meteorological values

Discipline: Global Atmospheric Monitoring

Topic 1. Atmospheric Monitoring

1.1. Global atmospheric monitoring in the context of comprehensive analysis of the natural environment
1.2. Analysis of ecological load at the regional level
1.3. Permissible load on biosphere elements. Threshold effect. Dose–response relationship
1.4. Stability and reserves of ecological systems. Ecological approaches to anthropogenic load regulation
1.5. Principles of environmental regulation considering multiple pollution pathways

Topic 2. Organization of Global Atmospheric Monitoring

2.1. General approaches to regulating environmental quality. Environmental-economic regulation aspects
2.2. Organization of monitoring atmospheric state, sources, and anthropogenic impact factors. Assessment and forecast of anthropogenic changes
2.3. Classification of global monitoring of anthropogenic atmospheric changes
2.4. Climate monitoring. Satellite-based climate monitoring

Topic 3. Applied Aspects of Global Atmospheric Monitoring

3.1. Transboundary air pollution and its monitoring
3.2. Global environmental monitoring systems
3.3. Global and regional forecasts of atmospheric conditions
3.4. Measures at various levels to reduce atmospheric emissions
3.5. Concept for improving air quality management in the Republic of Kazakhstan and implementation of selected protocols under the Convention on Long-range Transboundary Air Pollution

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