APPROVED
at the meeting of the Academic Council of NJSC Al-Farabi Kazakh National University
Protocol №14 dated 16.06.2026

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

I. General Provisions

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

2. The entrance examination for admission to the doctoral program consists of an interview, an essay, and a subject-specific examination in the relevant educational program group.

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 an electronic examination ticket. The interview is conducted at the university prior to the entrance examination.

II. Procedure for Conducting the Entrance Examination

1. Applicants to the doctoral program in the educational program group "D086 – METEOROLOGY" are required to write a problem-oriented/thematic essay. The essay must contain at least 250 words.

The purpose of the essay is to assess the applicant's analytical and creative abilities, as demonstrated through the capacity to develop and substantiate independent arguments based on theoretical knowledge, as well as social and personal experience.

Types of Essays:

- Motivational essay revealing the applicant's motivations for engaging in research activities;
- Scientific-analytical essay substantiating the relevance and methodology of the proposed research;
- Problem-oriented/thematic essay reflecting various aspects of scientific knowledge within the subject area.

2. The electronic examination ticket consists of three questions.

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

Discipline: Physical Meteorology

Topic 1. General Information about the Atmosphere

1.1. Composition of the Atmosphere.
1.2. Equation of State of Atmospheric Air.
1.3. Structure of the Atmosphere.

Topic 2. Atmospheric Statics

2.1. Fundamental Equation of Atmospheric Statics.
2.2. Barometric Formulas.

Topic 3. Radiation Regime of the Atmosphere

3.1. Solar Radiation.
3.2. Attenuation of Solar Radiation.
3.3. Laws of Radiation.
3.4. Radiation Emitted by the Earth and the Atmosphere.
3.5. Radiation Balance of the Earth's Surface, the Atmosphere, and the Earth–Atmosphere System.

Topic 4. Thermal Regime of Soil

4.1. Thermophysical Characteristics of Soil.
4.2. Soil Heating and Cooling Processes.
4.3. Propagation of Temperature Fluctuations into Soil Depth. Fourier's Laws.
4.4. Influence of Natural Surface Cover on Soil Temperature.

Topic 5. Atmospheric Thermodynamics

5.1. The First Law of Thermodynamics.
5.2. Adiabatic Processes.
5.3. Atmospheric Stability Criteria Based on the Air Parcel Method.
5.4. Moist Adiabatic Processes.
5.5. Atmospheric Stratification with Respect to Moist-Adiabatic and Dry-Adiabatic Air Parcel Motion.
5.6. Thermodynamic Diagrams.

Topic 6. Thermal State of the Atmosphere

6.1. Turbulent State of the Atmosphere. The Surface Layer.
6.2. Diurnal Variation of Air Temperature in the Atmospheric 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. Heat 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. Distribution of Humidity in the Troposphere and Stratosphere.
7.4. Evaporation and Evaporability (Potential Evaporation).

Topic 8. Clouds, Fog, and Precipitation

8.1. General Conditions for Water Phase Transitions in the Atmosphere.
8.2. Dependence of the Latent Heat of Phase Transition and Saturation Vapor Pressure on Temperature. Phase Equilibrium Diagram.
8.3. Physical Conditions for Fog Formation and Classification of Fogs.
8.4. Cloud Classifications (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. Formation and Classification of Precipitation.
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. Motion in the Free Atmosphere.
9.3. Characteristics of Air Motion in the Atmospheric Boundary Layer.
9.4. Local Winds.

Topic 10. Optical and Electrical Phenomena in the Atmosphere

10.1. Optical Phenomena Caused by the Scattering of Light in the Atmosphere.
10.2. Optical Phenomena Caused by the Refraction of Light Rays in the Atmosphere.
10.3. Optical Phenomena Caused by the Refraction and Reflection of Light Rays in Cloud Droplets and Ice Crystals.
10.4. Optical Phenomena Caused by the Diffraction of Light in Clouds and Fog.
10.5. Ionization of the Atmosphere.
10.6. The Ionosphere.
10.7. Auroras and Their Classification.

Discipline: Synoptic Meteorology

Topic 1. Meteorological Information and Methods of Its Presentation

1.1. Types of Meteorological Information.
1.2. Methods of Presenting Meteorological Information.
1.3. Main Tools of Synoptic Analysis.

Topic 2. Pressure Field and Wind Field

2.1. Atmospheric Pressure Field. Spatial Distribution of Pressure.
2.2. Forms of Baric Topography. Characteristics of Low- and High-Pressure Systems.
2.3. Force Balance in Cyclones and Anticyclones.
2.4. Features of Wind Field Analysis and Its Characteristics.
2.5. Geostrophic and Gradient Models of the Relationship Between Pressure and Wind Fields. Relationship Between Geostrophic and Actual Wind.

Topic 3. Temperature and Humidity Fields

3.1. Temperature and Humidity Fields Used in Synoptic Analysis. Factors of Their Local Variability.
3.2. Advective Changes in Temperature and Humidity.
3.3. Temperature Changes Associated with Vertical Air Motions.

Topic 4. Vertical Motions in the Atmosphere and Their Calculation

4.1. Types of Vertical Air Motions, Their Spatial and Temporal Scales, and Relation to Weather Conditions.
4.2. Convective Vertical Motions.
4.3. Organized Vertical Motions.
4.4. Qualitative Assessment of the Sign and Intensity of Organized Vertical Motions Based on the Structure of the Pressure Field.

Topic 5. Air Masses

5.1. Concept of an Air Mass and Its Source Region.
5.2. Conditions for Air Mass Formation.
5.3. Classification of Air Masses.
5.4. Weather Characteristics in Warm and Cold Air Masses with Different Stratification

Across Seasons.
5.5. Transformation of Air Masses.

Topic 6. Atmospheric Fronts

6.1. Classification of Atmospheric Fronts.
6.2. Distribution Features of Meteorological Variables and Cloud Systems in the Region of Different Types of Fronts.
6.3. Characteristics of Warm Fronts, Cold Fronts, and Occluded Fronts.
6.4. Movement of Fronts.
6.5. Evolution of the Spatial Structure of Atmospheric Fronts.
6.6. Frontolysis and Frontogenesis.
6.7. Influence of Orography on the Movement and Spatial Structure of Atmospheric Fronts. Masking of Atmospheric Fronts.
6.8. Main Stages of Synoptic Analysis of Fronts.
6.9. Methods for Forecasting Front Movement.

Topic 7. Upper-Level Frontal Zones and Jet Streams

7.1. Definition and Main Characteristics of Upper-Level Frontal Zones.
7.2. Classification of Upper-Level Frontal Zones.
7.3. System of Planetary Frontal Zones in the Northern Hemisphere.
7.4. Classification of Jet Streams. Parameters of Jet Streams.
7.5. Distribution Features of Vertical Motions and Cloudiness in Jet Streams.
7.6. Energetics of Jet Streams.

Topic 8. Temporal Changes in Surface Pressure and Geopotential Heights

8.1. Local Change in Geopotential Height Over Time.
8.2. Qualitative Assessment of the Sign and Intensity of Cyclogenesis and Anticyclogenesis Based on the Structure of the Pressure Field and Its Temporal Changes.
8.3. Modern Theory of Cyclogenesis and Anticyclogenesis.

Topic 9. Cyclones and Anticyclones

9.1. Classification of Cyclones and Anticyclones. Stages of Their Development.
9.2. General Characteristics of Extratropical Cyclones and Anticyclones.
9.3. Conditions for Formation and Development of Thermal and Frontal Cyclones in Mid-Latitudes. Stages of Development of Frontal Cyclones.
9.4. Structure of the Thermobaric Field and Weather Conditions in Different Stages of Cyclone Development. Cyclone Families.
9.5. Conditions for Formation of Extratropical Anticyclones. Stages of Anticyclone Development.
9.6. Structure of the Thermobaric Field and Weather Conditions in Each Stage of Anticyclone Development. Regeneration of Anticyclones.
9.7. Blocking Anticyclones.
9.8. Regeneration of Cyclones and Anticyclones.
9.10. Influence of Orography on the Movement of Baric Systems. Rules of Cyclone and Anticyclone Movement.
9.11. Forecasting the Movement of Cyclones and Anticyclones.
9.12. Forecasting the Evolution of Baric Systems.
9.13. Influence of Orography on the Formation, Evolution, and Movement of Cyclones and Anticyclones.

Discipline: Climatology

Topic 1. Main Factors of Climate Formation

1.1. Concept of Climate.
1.2. The Climate System and Its Characteristics.
1.3. Astronomical and Geophysical Factors of Climate Formation.

1.4. Energy 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 Regularities of the Geographical Distribution and Temporal Variability of the Components of the Radiation and Heat Balance of the Earth's Surface.
1.9. Active (Underlying) Surface and Its Influence on Climate Formation.
1.10. Influence of Snow and Ice Cover on Climate.
1.11. Influence of the Distribution of Land and Sea 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 the General Circulation of the Atmosphere.
2.2. Characteristic Features of Predominant Zonal Circulation. Zonal Circulation in the Troposphere and Stratosphere.
2.3. Quasi-Biennial Oscillation and Its Nature.
2.4. Cyclonic Activity, Pressure Field, and Near-Surface Air Circulation.
2.5. Atmospheric Circulation in the Tropical Zone: Trade Winds, the Intertropical Convergence Zone, Tropical Cyclones.
2.6. Monsoon Circulation. Monsoons of Tropical and Extratropical Latitudes.
2.7. Planetary Long Waves (Rossby Waves).
2.8. Frequency of Cyclones and Anticyclones. Centers of Action of the Atmosphere.
2.9. Climatological Fronts.

Topic 3. General Ocean Circulation and Its Influence 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 Variations in Sea Surface Temperature of 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. Oceanic Energy-Active Zones.

Topic 4. Temperature Field and Factors Determining It

4.1. Geographical Distribution and Temporal Variability of Air Temperature on the Earth.
4.2. Zonal Temperature Field in the Lower Atmosphere and at Upper Levels.
4.3. Influence of the 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 Cloud Fields and Their Role in Climate Formation

5.1. Main Characteristics of the Humidity Field.
5.2. Spatial and Temporal Distribution of Humidity Characteristics and Precipitation.
5.3. Combined Influence of Thermal Regime and Moisture Conditions on Climate. Droughts.
5.4. Horizontal Transport of Moisture in the Atmosphere.
5.5. Atmospheric Moisture Content. The Atmospheric Moisture Cycle.
5.6. Moisture Balance over Continents. Semi-Empirical Theory of the Moisture Cycle.

Topic 6. Climate Classification

6.1. Purpose of Climate Classifications for Scientific and Applied Tasks.
6.2. Difference Between the Concepts of "Classification" and "Zoning (Regionalization)".

6.3. Early Climate Classifications.
6.4. Köppen Climate Classification, Its Advantages and Disadvantages.
6.5. Landscape–Botanical Classification by L.S. Berg.
6.6. Genetic Classifications (B.P. Alisov, M.I. Budyko, and A.A. Grigoryev).
6.7. Botanical Climate Classifications.
6.8. Distribution of the Main Climatic Characteristics in Different Parts of the World Based on Classification Results.

Topic 7. Meso- and Microclimate

7.1. Concept of Meso- and Microclimate.
7.2. Microclimate as a Phenomenon of the 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 Variability and Climate Change

8.1. Climate Variability, Climate Changes, and Climate Fluctuations.
8.2. Contemporary Natural and Anthropogenic Climate Changes.
8.3. Changes in the Characteristics of the Earth's Active Surface: Urbanization, Aerosol, Gas, and Thermal Pollution of the Atmosphere.
8.4. Changes in the Concentration of CO_2 and Other Trace Gases Due to Human Activity.
8.5. General Circulation Models of the Atmosphere and Ocean.
8.6. Contemporary Scenarios of Future Climate Change.
8.7. Global and Regional Changes in the Modern Climate.

Discipline: Features of the General Atmospheric Circulation

Topic 1. Types and Indices of Atmospheric Circulation

1.1. Circulation Types by B.L. Dzerdzeevskii.
1.2. Classification of Atmospheric Processes by G.Ya. Vangengeim – A.A. Girs.
1.3. Types of Synoptic Processes by M.Kh. Baidala.
1.4. Forms of Atmospheric Circulation by A.L. Kats.
1.5. Rossby Indices of Atmospheric Circulation.
1.6. Circulation Index by E.N. Blinova.
1.7. General Circulation Index by A.L. Kats.

Topic 2. Main Regularities of the General Atmospheric Circulation

2.1. Use of Generalized Indicators of the General Atmospheric Circulation and Their Characteristics in Forecast Schemes.
2.2. Quantitative Indices of the Intensity of the General Atmospheric Circulation (Rossby, Blinova, Kats) as Predictors in Forecast Schemes.
2.3. Circumpolar Vortex and Its Characteristics in Winter and Summer Seasons. Use of Spring and Autumn Stratospheric Circulation Transition Dates in Forecasting Hazardous Weather Events.
2.4. General Atmospheric Circulation and Solar Activity.
2.5. Nature of Solar–Terrestrial Connections. Heliophysical Impacts on the Earth's Pressure Field.
2.6. Relationship Between Extreme Weather Conditions and Solar Activity. Droughts and Severe Winters in the 11-Year Solar Cycle. Geomagnetic Disturbances as an Indicator of the Likelihood of Droughts and Severe Winters.
2.7. Variations in Earth's Rotation Parameters (Angular Velocity, Nutation of the Earth's Axis) and Their Influence on General Atmospheric Circulation and Weather Processes.

2.8. The El Niño Phenomenon and Its Role in the Formation of Extreme Weather Conditions on the Continent.

Topic 3. Accounting for the Influence of the Underlying Surface in Long-Term Weather Forecasts

3.1. Features of Using Characteristics of the Underlying Surface in Long-Term Weather Forecasts: Synoptic-Climatological and Statistical Studies.

3.2. Interaction Between the Ocean and the Atmosphere. Types of Interaction: Small-Scale and Large-Scale Interactions; Heat Engines of the First and Second Kind According to Shuleikin.

3.3. Large-Scale Ocean–Atmosphere Interaction. The Duvanin Model.

3.4. Role of the North Atlantic in the Formation of Weather in Kazakhstan.

3.5. Role of the Pacific Ocean in the Formation of Weather in Kazakhstan.

3.6. Influence of Arctic Sea Ice Extent on Weather Formation over the Continent.

3.7. General Circulation Models of the Atmosphere and Ocean.

Discipline: Forecasting of Natural Disasters

Topic 1. General Scientific Problems of Forecasting

1.1. Methodological Problems of 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 and Demographic Assessment of a Territory.

2.2. Possibilities of Deterministic Forecasting of Hazardous Natural Phenomena.

2.3. Analysis of Methods for Forecasting Hazardous Convective Phenomena.

2.4. Methods of Probabilistic Forecasting of Hazardous Natural Phenomena.

2.5. Interpretation of Results of Synoptic-Statistical Methods for Forecasting Hazardous Weather Phenomena.

Topic 3. Natural Hazard Emergency Situations

3.1. Classification of Emergency Situations.

3.2. Quantitative Assessment of the Scale of Disasters.

3.3. Geographical Component of the Index of Potential Losses from Hazardous Natural Phenomena.

3.4. Determination of Average Consumer Losses When Relying on the Predicted Value of a Meteorological Element.

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 Environmental Load at the Regional Scale.

1.3. Permissible Load on Biosphere Components. Threshold Effects. Dose–Response Relationship.

1.4. Stability and Resilience of Ecological Systems. Environmental Approaches to Regulating Anthropogenic Loads.

1.5. Principles of Environmental Standardization Considering Multiple Pathways of Pollutant Exposure.

Topic 2. Organization of Global Atmospheric Monitoring

2.1. General Approaches to Environmental Quality Regulation. Ecological and Economic Aspects of Regulation.

2.2. Organization of Observations of Changes in Atmospheric Conditions, Sources, and Factors of Anthropogenic Impact. Assessment and Forecasting of Anthropogenic Changes.

2.3. Classification of Global Monitoring of Anthropogenic Changes in Atmospheric Conditions.

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 System.

3.3. Global and Regional Forecasts of Atmospheric Conditions.

3.4. Measures at Different Levels to Reduce Atmospheric Emissions.

3.5. Concept for Improving Air Quality Management in the Republic of Kazakhstan and Implementation of Selected Protocols to the Convention on Long-Range Transboundary Air Pollution.

III. List of References

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