

## Entrance tests

Acid-base equilibrium.

Oxidation-reduction equilibrium Electrochemical methods. Theoretical bases Gas-liquid chromatography.

Metrological basics for a chemical analysis Modern concepts of the nature of the chemical bond

General principles of reactivity

Nucleophilic substitution at a multiple carbon-carbon bond and in the aromatic nucleus. Accession by multiple carbon-carbon bonds.

Nucleophilic addition to the carbonyl group

Concerted reactions

Alkanes and halogen derivatives of alkanes

Alkenes and dienes

Alkynes

Alcohols and simple ethers

Aldehydes and ketones

Carboxylic acids and derivatives thereof

Heterocyclic compounds

Theory of aromaticity and heteroaromaticity.

The fundamentals of the thermodynamics of chemical processes and phase equilibria Kinetics, mechanism and catalysis of reactions.

The fundamentals of electrochemistry

The electrochemical synthesis, electrolysis and dimensional processing of materials.

The chemical sources of electrical power

The classification of processes for obtaining liquid components of fuels, lubricants, petroleum binders and solid hydrocarbons

Modern methods for studying hydrocarbon raw materials

General principles of preparation and classification of commercial petroleum products

Physico-chemical-mechanical and operational properties of gasolines, diesel, jet, gas turbine and boiler fuels, oils, greases and technical liquids

The main directions of the technical process in crude oil processing.

Physical and physicochemical methods of studying the structure of coals.

The physical properties of coals, such as calorific value, density, strength, electrical conductivity, heat capacity, thermal conductivity and their changes depending on the degree of coalification

Processes that occur during coking of caking coal and coal charge.

A range of carbon sorbents (porous carbon materials) obtained on the basis of fossil coals, and sorbent quality requirements.

The graphitised electrodes for smelting iron and steel, cathode blocks for lining electrolyzers for aluminium smelting, carbon electrodes for silicon smelting

Cokes, such as petroleum, pitch, slate etc.

The role of binders in the production of carbon materials. Types of binders used. Characteristics of binders.

The ideal mixing model. Derivation of the differential equation of the model

Equations and boundary conditions for hydrodynamics.

Hydrodynamics of thin flowing films. Stream flows

Diffusion to a spherical particle, a drop and a bubble in a linear shear flow for small Reynolds numbers and any Peclet numbers

The structure and structural relationships of solid dispersed media.

Drying kinetics. Contact dryers. Dryers with a stationary layer. Dryers with the pseudofluidised and fluidised beds.

Heterogeneous catalytic reactors; the classification of catalytic reactors according to constructive and hydrodynamic features

Mass transfer in the forward flow at low Peclet numbers.

The phase rule, design methods and basic types of state diagrams.

Hess law and its application to determine the thermal effects of the formation of silicate and refractory non-metallic materials.

The main regularities of the formation of the phase composition of the silicate and refractory non-metallic materials.

Solid-phase reaction mechanisms and kinetics.

The physical and chemical essence of the hydration and hardening of binders.

The influence of the chemical and phase composition and performance characteristics of the silicate and refractory non-metallic materials. The classification and characterisation of basic and auxiliary raw materials. The physical and mechanical preparation of raw materials; the features of obtaining highly disperse and nanopowders.

Properties, applications and methods of obtaining inert gases, nitrogen, oxygen, hydrogen and synthesis gas.

The ammonia and nitric acid technology. Their properties and application

Nitrogen-, phosphorus- and potassium-containing fertilizers, complex fertilizers and microfertilizers. Properties and application. Techniques for producing.

Classification, properties and applications. The key methods of obtaining salts and reagents of mineral and organic acids

The main methods of production, properties and application of calcium carbide, thermal phosphorus, thermal phosphoric acid, products of the plasma chemical technology. The classification and nature of impurities. The analysis and deep substance purification methods. The structural material and process environment purity requirements

The processing properties and characteristics of raw mixtures (semi-dry masses, suspensions, slurries, sludges and pastes).

The structure and rheological properties of dispersed systems; their relationship with the moulding processes. The main methods and processing characteristics associated with product moulding in the silicate and refractory non-metallic material technology.

The heat and mass transfer processes when drying the silicate and refractory non-metallic materials. The main types of drying aggregates. The conditions and methods of heat transfer during roasting, the main types of thermal aggregates.

The sintering processes, their classification, and the stages of sintering.

The essence, features, driving force, mechanisms, sintering kinetics and recrystallisation kinetics.

The modes of and conditions for obtaining homogeneous melts in the glass and glass ceramic technology. The methods and processes of obtaining oxide melts.

Crystallisation of melts.

New processes of obtaining the silicate and refractory non-metallic materials; growing whiskers, the plasma-chemical production of powders and coatings, self-propagating high-temperature synthesis and the pulsed high-energy impact.

The chemical principles of creation of the low-stage chemical production. Developing methods for obtaining products from affordable and inexpensive raw materials.

The nuclear and physical properties of zirconium and hafnium. The application of zirconium and hafnium compounds in nuclear power engineering.

The discovery of zirconium and hafnium in nature. The industrial zirconium and hafnium minerals. Enrichment of ores containing zirconium.

The interaction of zirconium and hafnium with acid and base solutions.

Separation of zirconium and hafnium in the industrial technology.

Obtaining zirconium powders by the electrolysis of salt melts.

Obtaining zirconium and hafnium halides.

Obtaining hafnium powders by electrolysis of salt melts.

Obtaining metallic zirconium with the Kroll method.

Obtaining metallic hafnium by the Kroll method.

Refining metallic zirconium and hafnium.

Obtaining zirconium of the nuclear purity.

Obtaining zirconium and hafnium alloys used in nuclear power engineering.

The ammonia and nitric acid technology. Their properties and application

Nitrogen-, phosphorus- and potassium-containing fertilizers, complex fertilizers and microfertilizers. Properties and application. Ways of obtaining.

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The process properties and characteristics of raw mixtures (semi-dry masses, suspensions, slurries, sludges and pastes).

The structure and rheological properties of dispersed systems, their relationship with moulding. The key methods and process characteristics of moulding products in the silicate and refractory non-metallic material technology.

The heat and mass transfer processes in drying silicate and refractory non-metallic materials.

The main types of drying aggregates.

The conditions and methods of heat transfer during roasting; the main types of thermal aggregates.

The sintering processes; their classification, the stages of sintering.

The essence, features, driving force, mechanisms, the kinetics of sintering and re-crystallisation.

Modes of and conditions for obtaining homogeneous melts in the glass and ceramic glass technology. The methods and processes of obtaining oxide melts.

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Refining metallic zirconium and hafnium.

Obtaining zirconium of the nuclear purity.

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The nuclear and physical properties of uranium. The use of uranium in nuclear power.

Acidic breaking down the uranium-bearing ores.

Underground uranium leaching.

Purification of uranium concentrates to produce commodity ammonium uranyl tricarbonate.

Wet methods for obtaining uranium tetrafluoride.

Dry methods for obtaining uranium tetrafluoride.

Obtaining nitrous oxide of uranium.

Production of uranium dioxide.

Obtaining uranium hexafluoride.

The calciumthermic method of obtaining metallic uranium.

The production of metallic uranium and its alloys by the electrolysis of melts.

Refining metallic uranium.

The nuclear and physical properties of thorium. Prospects for the use of thorium in nuclear power engineering. Finding thorium in nature. The industrial thorium minerals. The enrichment of thorium-bearing ores.

Phosphate-oxalate scheme of processing monazite concentrates.

The fluoride oxalate scheme for monazite concentrate processing.

The sulphate scheme for monazite concentrate processing. Scheme with double sulfates. Processing monazite concentrates by dry chlorination.

The oxalate method for the purification of thorium from lanthanides.

The purification of thorium by the fractional crystallisation of sulfates.

The extraction purification of thorium.

The ion-exchange purification of thorium.

Obtaining thorium fluoride.

Obtaining thorium chloride.

The characteristics and isotopic composition of SNF.

Removal of the envelope of fuel elements (fuel opening) during SNF processing.

Dissolution of SNF components in aqueous solutions.

The behaviour of plutonium in aqueous solutions, the degree of oxidation, disproportionation of Pu (IV) and Pu (V), hydrolysis, complexation, stabilisation of the valence forms of plutonium. The characteristics of extractants used in the radiochemical industry for reprocessing of spent nuclear fuel.

Physico-chemical basis for the use of extractants in the reprocessing of SNF.

The use of tributyl phosphate (TBP) for SNF regeneration (selection of diluent, extraction of uranium, plutonium, fission products, separation of SNF components, TBP radiolysis and the impact of its effects on process indicators).

The preparation and properties of plutonium dioxide.

The preparation and properties of plutonium halides ( $\text{PuF}_3$ ,  $\text{PuF}_4$ ,  $\text{PuF}_6$ ,  $\text{PuCl}_3$ ).

Metallic plutonium, the physical and chemical properties.

Obtaining metallic plutonium.

The gas-fluoride technology for SNF reprocessing (the physical and chemical basis and separation of SNF components).

The pyroelectrochemical SNF regeneration methods.

Salt and liquid metal solvents for SNF; oxide and metallic fuel dissolution.

The pyroelectrochemical regeneration of the irradiated oxide mixed (uranium-plutonium) fuel of fast-neutron reactors in salt melts.

Pyroelectrochemical processing of the irradiated metallic mixed fuel in salt melts with liquid metal melts.

Basic electrochemical phenomena during electrolysis. Faraday Laws.

The nature and mechanism of the appearance of the electrode potential. The thermodynamic formula for the equilibrium electrode potential.

The structure of a double electrical layer at the electrode-electrolyte interface.

The kinetics of electrochemical processes. Diffusive overstrain. The electrochemical overvoltage. Basic provisions of the slowed discharge theory. Basic regularities of mixed kinetics.

Overstrain of crystallisation.

The effect of surfactants on the kinetics of the electrodeposition process and the sediment structure.

The characterisation of the main electrolytic metal production processes in compact and powder forms.

Basic regularities of anodic dissolution of metals.

The ion discharge theory. The electrodeposition of alloys. The electrocrystallisation and structure of alloys.

Theoretical bases of work and design of the main chemical sources of current. The electrochemical power source characteristics.

Passivity of metals. The film and adsorption theory of passivity. Salt passivity. Electrochemical corrosion of metals.

The methods for studying corrosion processes. The polarisation diagram method. The electrochemical corrosion protection methods.