Subject Areas for MSc. Admission Exam

Study program Sustainability and Environmental Engineering

Sub-program Sustainability and Environmental Engineering

Subject Area "Inorganic Chemistry"

1. Periodic law and atomic structure, atom, atomic and mass numbers, the classification of elements.
2. Ion and metal bonds, electronegativity, oxidation state, the properties of ionic compounds, ions in solutions, the solubility of salts, the properties of metals.
3. Covalent bond, structural formulas, VSEPR (Valence shell electron pair repulsion theory), atomic orbital hybridization. The properties of molecular and covalent solids.
4. Hydrogen, oxygen, bonding possibilities, preparation and production, water, acids and bases, the classification of oxides, peroxides.
5. Halogens, noble gases, bonding possibilities, van der Waals interactions, chlorine preparation and production, hydrogen halides, halides, oxides, chlorine oxoacids and their salts.
6. Sulfur, bonding possibilities, sulfur structure, hydrogen sulfide and sulfides, sulfur oxides, sulfuric acid, peroxo-, thio- and chlor- derivatives of sulfuric acid.
7. Nitrogen, phosphorus, bonding possibilities, preparation and production, ammonia, phosphine, hydrazine, azoimide (hydrazoid acid), nitrides, azides, phosphides, the oxides of nitrogen, nitrous and nitric acid, nitro compounds, phosphorus oxides and oxides, polyphosphates.
8. Carbon, silicon and boron, allotropic carbon modifications, silicon and semiconductors, bonding possibilities, carbides, the oxides of carbon, silicon dioxide, silicates and silicones, boric acid.
9. Metals, non-transition and transition metals, bonding possibilities of s-, p- and d-metals, group trends, the stabilization of oxidation states, the production of important metals (Fe, Al, Cu, Pb, Zn, Sn, Ni, Ti).
10.

Subject Area "Organic Chemistry"

1. Alkanes and cycloalkanes - structure and reactivity, constitutive, configuration, conformational isomerism.
2. Alkenes - structure, electrophilic and radical reactions on double bond and in chain.
3. Alkynes - acidity, the alkylation of anion, the reactivity of triple bond, the stereochemistry of organic compounds.
4. Halogenalkanes (haloakanes) - structure, nucleophilic substitution, stereochemistry, mechanism.
5. E2 and E1 elimination, relation to nucleophilic substitution, dehydrohalogenation, dehydration.
6. Conjugated systems - allylic cations, dienes, their stereochemistry and reactivity.
7. Arenes (aromatic hydrocarbons) - aromaticity, electrophilic substitution, mechanism, the basic types of reactions.
8. Alcohols and phenols - structure, acid-base properties, reactions with nucleophiles, dehydration, oxidation. Ethers and epoxies.
9. Carbonyl compounds - structure, nucleophilic addition to the carbonyl group, aldolization and related reactions.
10. Carboxylic acids and functional derivatives - structure, acidity, nucleophilic acyl substitution, Claisen condensation and related reactions

Subject Area "Analytical Chemistry"

1. Volumetric and gravimetric analysis (basic concepts, the distributions and principles of titration methods, equivalence point and its indication)
2. Potentiometry, pH measurement (electrode types, electrode selectivity, direct potentiometry, potentiometric titration)
3. Current-flowing electrochemical methods (voltammetry, polarography, coulometry)

4. Gas and liquid chromatography (the overview and principles of each technique, important quantities, detection methods, qualitative and quantitative analysis)
5. Lambert-Beer's law and its usage (quantities, the deviations from validity, application)
6. Spectrometric instrumentation (basic building units for emission, absorption, and fluorescence spectrometers)
7. Atomic spectrometry techniques (the overview and principles of individual techniques)
8. Molecular spectrometry techniques (the overview and principles of individual techniques)
9. Mass spectrometry (the parts of mass spectrometer, ionization and ion separation techniques, the application in qualitative and quantitative analysis)