LIST OF ENTRANCE EXAM QUESTIONS

FOR THE INTERNATIONAL MASTER'S DEGREE PROGRAM

ITMO

INFOCHEMISTRY

Section 1. Information theory and chemical self-organization, thermodynamics, selected chapters of colloid chemistry

1. Complex chemical systems (e.g. biological cell).
2. Self-organized systems.
3. General aspects of thermodynamics. Equilibrium and nonequilibrium phase transitions.
4. Mechanical and thermodynamic equilibrium.
5. Nonlinear chemical reactions.
6. The first law of thermodynamics. Internal energy. Enthalpy.
7. The consequences of the first law thermodynamics.
8. Gibbs free energy.
9. The content and formulation of the second law of thermodynamics. Reversible and irreversible processes.
10. Entropy. Change in entropy in some processes: during phase transformations, during Heating system, in chemical reaction.
11. Application of the first law of thermodynamics to chemical processes. Hess's Law. Calculation Thermal effects of chemical reactions based on Hess's law. Dependence of the thermal effect on temperature. Kirchhoff's equation.
12. Heat capacity. Expression of heat capacity in isobaric and isochoric conditions. Addiction Heat capacity from temperature.
13. Isochoric-isothermal potential and Isobaric isothermal potential.
14. The concept of the chemical potential. The chemical potential of an individual substance in real mixture.
15. The law of mass action. The equilibrium constant of a chemical reaction. Ways of expression. Equilibrium constant.
16. The isotherm equation chemical reaction. The effect of temperature on chemical equilibrium. Isobar equation and isochore chemical reaction.
17. The third law of thermodynamics. Nernst's heat theorem. Postulates of Planck.
18. Dependence of the heat of the phase transition on pressure and temperature. Clausius– Clapeyron relation.
19. Molecular-kinetic properties of colloidal systems.
20. Adsorption processes at the interface of phases. Physical and chemical adsorption. Polyany's theory of polymolecular adsorption. BET Theory.
21. Synergetics, and systems far from thermal equilibrium. The Second Law of Synergetics.
22. Linear oscillator. Properties of linear systems.
23. Information. Increment of information. Shannon's entropy. The principle of maximum information. Coding information.
24. Storage and processing of information.
25. Application of the information maximum principle to self-organized systems.
26. Application of the information maximum principle to nonequilibrium phase transitions.
27. Pattern recognition algorithm.
28. Chemical process modeling, prediction and control.
29. Quantum computing, classical and quantum logic elements.

Section 2. Electrochemistry

1. Research methods for electrolyte solutions. Theory of electrolytic dissociation.
2. Debye-Hückel theory and activity coefficients.
3. Charge transport properties through polyelectrolyte layers and electrochemical methods investigation of them.
4. Nonequilibrium phenomena in electrolyte solutions. Diffusion and migration of ions. Electrical conductivity. Ion transport number.
5. Types and properties of ionic liquids. Types and properties of solid electrolytes.
6. Electrical double layer.
7. Electrochemical potential. The equilibrium in the electrochemical circuit.
8. Redox half-reactions, electrode potential.
9. Classification of electrodes for voltammetry. Ultramicroelectrodes.
10. Ion-selective electrodes: types, classification, Nernst equation and mathematical model description.
11. Electrochemical sensors.
12. Ultra-micro electrodes10. Application of the first law of thermodynamics to chemical processes. Hess's Law. Calculation Thermal effects of chemical reactions based on Hess's law. Dependence of the thermal effect on temperature. Kirchhoff's equation.

RECOMMENDED LITERATURE (IN ENGLISH)

1. Graham R., Knuth D., Patashnik O. Concrete Mathematics: A Foundation for Computer Science.
2. Неорганическая химия: В 3 т. / Под ред. Ю. Д. Третьякова. Т. 1: Физико-химические основы неорганической химии: Учебник для студ. высш. учеб. заведений / М.Е.Тамм, Ю. Д. Третьяков; — М.: Издательский центр «Академия», 2004. — 240 с. https://cdn.bc-pf.org/resources/chemistry/inorg_chem/Tretyakov_neorg_himiya_tom_1.pdf
3. Дамаскин Б.Б. и др.
4. Электрохимия / Б.Б.Дамаскин, О.А.Петрий, Г.А.Цирлина. — 2е изд., испр. и перераб. — М.: Химия, КолосС, 2006. — 672 с.: ил. — (Учебники и учеб. пособия для студентов высш. учеб. заведений).

(http://www.elch.chem.msu.ru/rus/fnm/elbook_all.pdf)

5. Шашкова Л.В. Введение в синергетику. От классической (равновесной) к современной (неравновесной) термодинамике и синергетике: учебное пособие/Л.В.Шашкова. — Оренбург: ГОУ ОГУ, 2006. — 146 с. http://elib.osu.ru/bitstream/123456789/7255/1/2434_20110920.pdf
6. Shriver & Atkins Inorganic chemistry, 5th edition.
7. Atkins' physical chemistry, 11th edition.
8. Organic chemistry, J. Clayden, N. Greeves, S. Warren.
9. Семиохин И.А. Физическая химия: Учебник. — Изд-во МГУ, 2001. — 272 с. http://chemnet.ru/rus/teaching/semiochin/physchim.pdf