

**Примерные вопросы к экзамену по дисциплине  
«Химия»  
для англоязычных студентов 1 курса  
факультета иностранных студентов**

1. Colligative properties of dilute solutions of non-electrolytes. Raoult's law and its consequences: decreasing of crystallization temperature, increasing the boiling point of solutions, osmosis.
2. Define the concepts: osmosis, osmotic pressure, oncotic pressure. Write a formula for the calculation of the osmotic pressure for non-electrolytes and electrolytes, blood.
3. What solutions are called: isotonic, hypotonic, hypertonic. Their role in medicine.
4. Give the definition of a Bronsted acid. Specify the types of acids, give examples. For acids those you have written provide the conjugate bases.
5. Explain what ampholytes according to the theory of Bronsted and Lowry as an example bicarbonate anion.
6. Protolytic reactions. Main provisions of the protolytic theory of acids and bases, molecular and ionic acids and bases. Conjugate protolytic pair, ampholytes. pH value
7. Give the definition of pH, derive it on the basis of the ionic product of water.
8. Give the definition of the concept of "buffer system". Give examples of cationic and anionic buffer systems.
9. Derive the formula of the pH of buffer systems on the example of bicarbonate buffer (equation of Henderson-Gasselbah). Explain what factors affected on the pH of the buffer solution.
10. What is called the buffer capacity of the solution? From what factors it depends? Zone of buffer action.
11. Alkalosis, acidosis: types and reasons of occurrence.
12. Explain the structure of complex compounds according to the coordination theory of Werner. For the answer use an example of a complex compound, which includes a complex anion
13. What is called the dentate of ligand? Give examples of mono-, bi- and polydentate ligands. Determine the denticity of water and oxalic acid.
14. The phenomenon of isomorphism: substitution of hydroxide ions to fluoride ions, calcium ions, strontium ions in hydroxyapatite. Osteotropic of metals. The reactions that underlie in the formation of concretions: urates, oxalates, carbonates. Use of calcium chloride and magnesium sulphate as antidotes
15. Explain why the radionuclide  $\text{Sr}^{90}$  easily integrated into the bone. What dangerous in the replacement of part of the calcium ions on  $\text{Sr}^{90}$  for the body? Strontium and beryllium rickets.
16. The chemistry of the process of bone formation in osteoblasts and the factors contributing to this.
17. What is the mechanism of occurrence of redox potential? What factors affect the value of the redox potential? The equation of Nernst-Peters.

18. The adsorption of gases on solids. Langmuir equation and its analysis. Langmuir isotherm.
19. Formulate the rule Paneth - Faience, and its practical application.
20. Change of surface activity in homologous series (rule of Traube). The adsorption isotherm. Orientation of the molecules in the surface layer and the structure of biological membranes.
21. What kind of molecule called SAS, SIS, SNS. The behavior of these molecules in the polar and nonpolar solvents
22. List and describe condensing methods of sols obtaining. Classification of disperse systems.
23. Types of dialysis. Use of dialysis in biology and medicine.
24. At what stages can be divided the coagulation process? Describe attributes of each stage.
25. The mechanism and kinetics of the electrolyte coagulation. Neutralization and concentration coagulation.
26. What are the molecular-kinetic properties typical for dispersed systems? Compare the intensity of these properties in colloidal and true solutions.
27. Electro-kinetic properties of colloidal solutions: electrophoresis, electroosmosis, flow potential, sedimentation potential.
28. Biogenic elements. s – Elements. Qualitative tests for sodium ions. The importance of these elements in the body.
29. Biogenic elements. s – Elements. Qualitative tests for potassium ions. The importance of these elements in the body.
30. Biogenic elements. s – Elements. Qualitative reactions to ions of calcium. The importance of these elements in the body.
31. Biogenic elements. s – Elements. Qualitative reactions to ions of magnesium. The importance of these elements in the body.
32. Biogenic elements. p – Elements. Qualitative reactions for anions of p – Elements. The value of phosphorus in the functioning of the body.
33. Biogenic elements. p – Elements. Qualitative reactions for anions of p – Elements. The value of carbon and oxygen in the functioning of the body.
34. Biogenic elements. d – Elements. Qualitative reactions to ions of copper. The importance of these elements in the organism and their influence on the activity of enzymes.
35. Biogenic elements. d – Elements. Qualitative reactions to ions of zinc. The importance of these elements in the organism and their influence on the activity of enzymes.
36. Biogenic elements. d – Elements. Qualitative reactions to ions of iron. The value of iron in the organism.
37. Classification and nomenclature of organic compounds. Types of isomerism in organic compounds.
38. Electronic effects of molecules. Inductive and mesomeric effects.
39. Stereoisomerism. Chirality and enantiomers. Fischer projection formulas. Diastereomers.
40. Hydroxyacids. General and specific properties of  $\alpha$ -,  $\beta$ -,  $\gamma$ -hydroxyacids.

41. Oxoacids (aldehyde acids and ketone acids) General chemical properties of oxoacids. Keto-enol tautomerism of derivatives. Biorole of oxoacids.
42. Dicarboxylic acids (oxalic, malonic, succinic, glutaric acids).
43. Fused-ring five-membered heterocycles: indoles and purines. Their derivatives. Uric acid, adenine, guanine.
44. Five-membered heterocycles with one heteroatom. Furan, pyrrole, and thiophene. Bonding and acidity.
45. Chemical properties of pyrrole. Their derivatives: porphine, hemoglobin, chlorophyll.
46. Five-membered heterocycles with two heteroatoms. Oxazole, imidazole, thiazole. Bonding and acid-base properties.
47. Chemical properties of azoles. Their derivatives: thiamin, histidine, histamine.
48. Six-membered heterocycles with two heteroatoms. Pyrimidine: bonding and properties. Its derivatives: cytosine, thymine, uracil.
49. Definitions and classification of carbohydrates. Chirality in monosaccharides. Fischer projection formulas and D-, L-sugars.
50. The cyclic hemiacetal structures of monosaccharides. Pyranose and furanose structures. Anomeric carbon atom ( $\alpha$ -,  $\beta$ -forms). Mutarotation.
51. Disaccharides. Reducing and nonreducing sugars. Maltose, cellobiose, lactose, sucrose. Chemical properties of reducing sugars.
52. Polysaccharides. Starch, glycogen, cellulose. Primary structure and their hydrolysis.
53. Classification and nomenclature of amino acids. Isomerism of amino acids.
54. The acid-base properties of amino acids. Dipolar ion structure. The isoelectric point.
55. Chemical properties of amino acids.
56. Peptides. Structure of peptide bond. The primary, secondary, tertiary, quaternary structure of proteins. Peptide synthesis.
57. Nucleosides and nucleotides, their hydrolysis.
58. Heterocyclic base: the pyrimidines (cytosine, thymine, uracil) and the purines (adenine and guanine). Their lactim-lactam tautomerism. Complementary pairs and rule of Chargaff.
59. Secondary DNA structure.
60. Ribonucleic acids, RNA. Structure of RNA.

### **Практические навыки**

1. Sol of silver iodide AgI produced in excess of a solution of potassium iodide. Determine the charge of the particles in obtained sol, write the formula of its micelles and specify which of the electrolyte: potassium chloride, barium nitrate or aluminum sulfate - will have the greatest capacity for coagulating the resulting sol.
2. The salt complex  $[\text{Ag}(\text{NH}_3)_2]\text{Cl}$  is a compound of the cationic type. Determine the oxidation state and coordination number of the complexing agent. Make the equation of primary dissociation of salt. Write an expression of  $K_{\text{unst}}$ .

3. Complex salt  $K_4[Fe(CN)_6]$  compound is an anionic type. Determine the oxidation state and coordination number of the complexing agent. Make the equation of primary dissociation of salt. Write an expression of  $K_{unst}$ .
4. Write the structural formula of EDTA. Determine denticity compound as a ligand. Indicate areas of use in medicine and sanitary practice.
5. Over a solution of what substances: glucose,  $Na_3PO_4$  or  $NaCl$  vapor pressure of solvent will be less if the temperature and the mole fractions of substances are equal? Give a reasoned response, using the concept of isotonic coefficient.
6. Identify the isotonic factors for solutions:  $NaCl$ ,  $Na_2SO_4$  and  $Al_2(SO_4)_3$ .
7. Which of the above solutions at identical molar concentrations will have the largest vapor pressure of the solvent:  
a)  $NaCl$ ; b) fructose ( $C_6H_{12}O_6$ ); c)  $Al_2(SO_4)_3$ . Explain your answer.
8. On the titrating of 5 ml of acetate buffer spent 3 ml  $NaOH$  ( $C_f$ ) = 0.1 mol/l. Calculate the buffer capacity of the system, if the  $pH_0 = 3$  and after the titration  $pH = 7.5$ .
9. Write the structure of micelles  $AgI$  with an excess of  $AgNO_3$ . Describe the component parts and explain what factors underlie the stability of colloidal solutions.
10. Calculate the water hardness (mmol/l) if on the titration of the test sample of 5 ml of water spent 1.5 ml of EDTA solution ( $C_f$  = molar concentration of 0.05 mol/l). Specify the type of water hardness.
11. Calculate the pH of the solutions, if:  
a)  $[H^+] = 10^{-3}$ ; b)  $[H^+] = 10^{-9}$ .  
Specify the nature of the medium.
12. What happens to red blood cells when placed in:  
a) a hypertonic solution; b) a hypotonic solution;  
c) an isotonic solution? Give an explanation.
13. Schulze-Hardy rule. On the basis of laboratory work determine which anion has a maximum coagulation action when coagulation of iron hydroxide sol  $Fe(OH)_3$  was caused by the following electrolytes:  $KCl$ ,  $K_2SO_4$ ,  $K_3[Fe(CN)_6]$ .
14. What properties exhibited by the ligands and complexing agent in complex compounds? What is the degree of oxidation and the coordination number of the complexing agent in complexes  $[Pt(NH_3)_2Cl_2]$ ,  $[Cr(H_2O)_5Cl]Cl_2$ .

15. The instability constants of complex ions  $[\text{Co}(\text{NH}_3)_6]^{3+}$ ,  $[\text{Fe}(\text{CN})_6]^{4-}$ ,  $[\text{Fe}(\text{CN})_6]^{3-}$  are equal to  $6,2 \cdot 10^{-36}$ ,  $1,0 \cdot 10^{-37}$ ,  $1,0 \cdot 10^{-44}$ . Which of these ions is more resistant? For that ion write the expression of ion instability constants

16. In what order will precipitate slightly soluble electrolytes AgCl, AgBr, AgI, if in a solution containing ions of  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$  gradually add  $\text{AgNO}_3$  ( $K_s(\text{AgCl})=1,8 \cdot 10^{-10}$ , ( $K_s(\text{AgBr})=5,0 \cdot 10^{-13}$ ,  $K_s(\text{AgI})=8,3 \cdot 10^{-17}$ )? Explain answer.

17. Solubility constants  $K_s(\text{Ag}_2\text{SO}_4)=1,8 \cdot 10^{-5}$  и  $K_s(\text{CaSO}_4)=2,4 \cdot 10^{-5}$  comparable in magnitude. Are the molar solubility of these salts same? Substantiate the answer using the calculation formulas.

18. Explain the relationship of values EMF and  $\Delta G$ . Can this reaction proceed spontaneously:

$\text{SnCl}_2 + \text{FeCl}_3 \rightleftharpoons \text{SnCl}_4 + \text{FeCl}_2$ , if  $\varphi^0(\text{Sn}^{4+}/\text{Sn}^{2+}) = +0,15 \text{ B}$ ;  $\varphi^0(\text{Fe}^{3+}/\text{Fe}^{2+}) = +0,77 \text{ B}$ . Explain answer by calculations.

19. Indicate the direction of the reaction

$2\text{MnO}_2 + 3\text{I}_2 + 8\text{OH}^- \leftrightarrow 2\text{MnO}_4^- + 6\text{I}^- + 4\text{H}_2\text{O}$  at standard conditions if  $\varphi^0(\text{MnO}_4^-/\text{MnO}_2) = +0,60 \text{ B}$ ;  $\varphi^0(\text{I}_2/2\text{I}^-) = +0,54 \text{ B}$ . Explain answer by calculations.

20. Can hydrogen bromide solution be oxidized by a solution of potassium permanganate and potassium dichromate, if  $\varphi^0(\text{Br}_2/2\text{Br}^-) = +1,07 \text{ B}$ ;  $\varphi^0(\text{MnO}_4^-/\text{Mn}^{2+}) = +1,54 \text{ B}$ ;  $\varphi^0(\text{Cr}_2\text{O}_7^{2-}/2\text{Cr}^{3+})=1,33 \text{ B}$ ? Explain answer by calculations.

21. Sol of silver bromide was obtained in an excess of potassium bromide. Sketch out the structure of the micelles, specify constituent components.

22. Sol of barium sulfite produced by the reaction:

$\text{Ba}(\text{NO}_3)_2 + \text{K}_2\text{SO}_3 \rightarrow \text{BaSO}_3 \downarrow + 2\text{KNO}_3$ . Sketch out the structure of the micelle and provide sign of the charge of granules, if the stabilizer is  $\text{K}_2\text{SO}_3$ . Specify constituent components.

23. Silver chloride sol obtained by ion exchange reaction in an excess of sodium chloride. Sketch out the structure of the micelle and provide sign and magnitude of the charge of granules. Indicate constituent components.

24. The silver iodide sol obtained in an excess of silver nitrate. Provide a schematic structure of the micelles, and explain what determines the sign and magnitude of the charge of granules. Indicate constituent components.

25. Sol of barium sulfate obtained by double exchange reaction in an excess of potassium sulphate. Sketch out the structure of the micelle, specify potential-ions. Indicate constituent components.

26. Write the structure formula of the compound: a) 2,2,3-trimethylbutane; b) 3-methylbutanoic acid; c) 3,4,4-trimethyl-2-pentene.
27. Write the structure formula of the compound: a) 2-chloropropanoic acid; b) 3-oxooctanoic acid; c) 2,4-dimethyl-1-pentanol.
28. Write structural formulas for each of the following compounds: (a) 2-pentenoic acid; (b) N-methylbutanamide; (c) diethyl oxalate.
29. Write structural formulas for each of the following compounds: (a) benzoic anhydride; (b) dimethylformamide; (c) isobutyryl chloride.
30. Give the IUPAC names for these compounds: (a)  $C_6H_5CH_2CH=CHCOOH$ ; (b)  $CH_2=CHCONH_2$ ; (c)  $C_6H_5CH_2COOCH(CH_3)_2$ .
31. Give the IUPAC names for these compounds: (a)  $(CH_3CH_2CO)_2O$ ; (b)  $CH_3OOCCH_2CH_2CH_2COOCH_3$ ; (c)  $BrCH_2C(O)Cl$ .
32. Write the structural formulas for the following compounds: (a) anisole (methoxybenzene); (b) ethyl lactate; (c) p-toluic acid (4-methylbenzoic acid).
33. Write the structural formulas for the following compounds: (a) 2-chlorobutanoic acid; (b) iodoform (triiodomethane); (c) xylitol (1,2,3,4,5-pentanepentol).
34. Which of the following compounds represent aromatic heterocycles: (a) furan; (b) piperidine; (c) pyrimidine; (d) quinoline. Explain the reason for your choice.
35. Draw the lactim tautomeric form for (a) uracil and (b) cytosine.
36. What term would you use to describe the stereochemical relationship between: (a) D-glucose and D-mannose; (b) D-mannose and D-galactose?
37. Which of the following compounds belongs to reducing sugars: (a) D-glucitol; (b) D-gluconic acid; (c) 2-deoxy-D-glucose; (d) D-xylose. Explain the reason for your choice.
38. Draw the Haworth formulas for D-glucose 6-phosphate and  $\alpha$ -D-fructose 1,6-diphosphate, both formed in the glycolysis process.
39. Draw an equation for the hydrolysis reaction for ethyl  $\alpha$ -D-glucopyranoside.
40. Draw the structural formula for  $\beta$ -cellobiose, taking into account its systematic name O-D-glucopyranosyl-(1  $\rightarrow$ 4)- $\beta$ -D-glucopyranose.

41. Draw the Fischer projections and Haworth formulas in a pyranose form for the following monosaccharides: (a) N-acetyl-D-glucosamine (2-acetamido-2deoxy-D-glucose); (b) D-fructose; (c) L-arabinose.
42. Draw the Fischer projections for the following amino acids: (a) L-cysteine; (b) D-glutamine; (c) L-serine; (d) L-valine.
43. Write an equation for enzymic transamination between 2-oxopentanedioic acid and alanine. Name the products of the reaction.
44. Draw the structural formulas for each of the following peptides: (a) glutaminyserine; (b) alanylphenylalanine; (c) Glu-His-Gly. Give the name of the latter peptide.
45. Name the following amino acids by the substitutive IUPAC nomenclature: (a) alanine; (b) methionine; (c) aspartic acid.
46. Name the following amino acids by the substitutive IUPAC nomenclature: (a) phenylalanine; (b) leucine; (c) lysine.
47. Complete the following equations:  
(a) serine + excess NaOH  $\rightarrow$   
(b) valine + ethanol/HCl  $\rightarrow$  Name the products obtained.
48. Draw the structural formulas for each of the following peptides: (a) cysteinyllysine; (b) glycylproline; (c) Asn-Ser-Met.
49. Write equations for acid-catalyzed (HCl) hydrolysis of the following peptides: (a) phenylalanylvaline; (b) Phe-Glu; (c) Gln-Gly-Leu.
50. Write equations for base-catalyzed (NaOH) hydrolysis of the following peptides: (a) glutamyltyrosine; (b) Phe-Ile; (c) His-Met-Asn.

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