Problems on the discipline Colloid Chemistry of nanoparticles
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The problems are made on the base of the lecture course of the "Colloid chemistry of nanoparticles" discipline.

The size of nanoparticles. Methods of preparation.

1. Assuming that in a colloidal solution of gold, each particle is a cube with the edge length of $2 \cdot 10^{-8}$ m, calculate: a) the number of particles in 1 g of gold sol; b) the total surface area of gold particles. The density of gold equals to $19.6 \cdot 10^{3}$ kg/m^3.

2. Calculate the value of specific surface of the porcelain clay suspension (density equal $2.5 \cdot 10^{3}$ kg/m3), if the spherical suspension particles have a dispersion of $2 \cdot 10^{6}$ m^{-1}. Consider the suspension as monodisperse. Give the answer in m^{-1} and in m^2/kg.

3. The mercury sol consists of balls with a radius of $3 \cdot 10^{-7}$ m. What is the total surface of sol particles formed from 300 g of mercury? The density of mercury equals to $13{,}56 \cdot 10^{3}$ kg/m^3.

4. At 293 K, the dispersion of mist water droplets is 60 μm^{-1}. Calculate the total surface area (m^2) of mist droplets weighing 5 g, if the density of water is 1 g/cm^3.

5. At the production of an oil-in-water emulsion, the diameter of the droplets at machine mixing is $4 \cdot 10^{-6}$ m, and at manual mixing $2 \cdot 10^{-5}$ m. Find how many times the specific surface area of the emulsion of oil at machine mixing is greater than at manual mixing. The density of the oil is $1{,}1 \cdot 10^{3}$ kg/m^3.

6. Calculate the total surface of 250 g of coal dust with a particle diameter of $6 \cdot 10^{-5}$m. The density of coal is $1.8 \cdot 10^{3}$ kg/m^3.

7. Assuming that each particle is a cube with length of $2 \cdot 10^{-8}$ m in the colloidal solution of gold, calculate: a) the number of particles in 1 g of gold sol; b) the total surface area of gold particles. The density of gold is $19.6 \cdot 10^{3}$ kg/m^3.

8. Assuming that in the silver sol, each particle is a cube with an edge length $l = 4 \cdot 10^{-8}$ m, calculate how many nanoparticles can be obtained from $1 \cdot 10^{4}$ kg of silver. Calculate the total surface of the obtained particles and calculate the surface of one silver cube with a mass of $1 \cdot 10^{-4}$ kg. The density of silver is $10.5 \cdot 10^{3}$ kg/m^3.

9. Calculate the total surface area of 1 g of gold, which is crushed into regular cubes with an edge length of $5 \cdot 10^{-9}$ m. The density of gold equals to $19.6 \cdot 10^3$ kg/m^3.

10. The dispersion of gold nanoparticles of 2 g of colloidal gold is $5 \cdot 10^7$ m^{-1}. Taking the form of nanoparticles as cubes, determine what surface area they can cover, if they are tightly laid in a single layer. The density of gold is $19.6 \cdot 10^3$ kg/m^3.

11. The dispersion of the mercury sol of is $1.6 \cdot 10^7$ m^{-1}. Calculate: a) the total surface of the particles of 1 g of mercury; b) the total number of particles in the solution when crushing 0.1 g of mercury. Assume that the sol particles of mercury are spherical. The density of mercury is $13.56 \cdot 10^3$ kg / m^3.

12. Calculate the total surface of area of 2 g of platinum dispersed into regular cubes with an edge length of $1 \cdot 10^{-8}$ m. The density of platinum is $21.4 \cdot 10^3$ kg/m^3.

13. Calculate the specific surface of the hydrosol of arsenic sulphide, the average particle diameter of which is equal to $1.2 \cdot 10^{-7}$ m and the density equals to $3.43 \cdot 10^3$ kg/m^3. The answer should be given in m^{-1} and in m^2/kg.

14. The dispersion of colloidal gold particles is 10^8 m^{-1}. Taking gold nanoparticles as cubes, determine the surface area S_0, which they can cover if they are tightly laid in one layer. The mass of colloidal gold particles is 1 g. The density of gold is $19.6 \cdot 10^3$ kg/m^3.

15. Gold nanoparticles have the dispersion $D = 10^8$ m^{-1}. What length (L) of the thread when 1 g of gold cubes are placed one after another. The density of gold is $19.6 \cdot 10^3$ kg/m^3.

16. Calculate the total surface area of 2 g of platinum dispersed into regular cubes with an edge length of $1 \cdot 10^{-8}$ m. The density of platinum is $21.4 \cdot 103$ kg/m^3.

17. Write the micelle formula of $BaSO_4$ obtained at the interaction of $BaCl_2$ with excess concentration of Na_2SO_4.

18. $AlPO_4$ sol was obtained by reaction $AlCL_3$ and Na_3PO_4, $AlCl_3$ was in excess write the formula of the sol obtained. Write the colloid micelle formula.

19. In a sample of synthesized gold nanoparticles, the particle diameter is distributed approximately normally, with the arithmetic average and the mean square deviation **s** indicated below. Calculate the proportion of particles in the sample which diameters range from x_1 to x_2, (x_1 = 5.0 nm, x_2 = 10.0 nm) assuming $\mu = \bar{x}$ ($\bar{x}$= 7.1 nm) and σ = s (s = 2.4 nm).

20. In a sample of synthesized gold nanoparticles, the particle diameter is distributed approximately normally, with the arithmetic average and the mean square deviation **s** indicated. Calculate the proportion of particles in the sample which diameters range from x_1 to x_2, (x_1 = 5.3 nm, x_2 = 5.7 nm) assuming $\mu = \bar{x}$ ($\bar{x}$= 5.5 nm) and σ = s (s = 1.2 nm).

21. By mechanical dispersion method of 5 g of toluene in 1 liter of water the dispersed system is obtained with particles of toluene of spherical form with a radius of a) $2.5 \cdot 10^{-7}$ m, b) 25 nm. The density of toluene is 0.867 g/cm3. Calculate D dispersion, S_{sp} specific area, S_0 total area, V_0 total volum, m_0 total mass of toluene particles, N number of particles.

22. Write the reaction equation of Ag nanoparticles preparation using $AgNO_3$ and sodium citrate ($Na_3C_6H_5O_7$) by methods of precipitation.

23. Write the reaction equation of Au nanoparticles preparation using solutions of chloroauric acid $HAuCl_4$ and sodium citrate Na_3Cyt.

24. Describe the mutual coagulation process for nanosols of MnO_2 and $Fe(OH)_3$. Give the definition to mutual coagulation conception.

The size effect

1. How will the reactivity and solubility of powdered silver sulfide change if the average particle size is 1 μm, 10 nm at a temperature of 298 K? The surface tension is 2.21 J/m2, ρ = 7.23 g/cm3.

2. How will the reactivity be affected by the dispersion of mercury particles to a size of 100; 50; 30 and 20 nm? The surface tension is 0.4753 J/m2. ρ = 5.427 g/cm3.

3. How will the reactivity of powdered magnesium oxide MgO change at a temperature of 298 K if the average particle size is 10 and 100 nm? The surface tension is 1.0 J/m2. ρ = 3.58 g/cm3

4. How will the reactivity of powdered tungsten and its melting point change if the average particle size is 1 and 100 nm? The surface tension is 6.814 J/m2. The melting point of tungsten is 3380 °C. The specific heat of fusion is 191 kJ/kg.

5. There are two nanomaterials of the same chemical composition, consisting ofspherical particles. The average radius of the particles of the first material is 20 nm, and the second is 100 nm. Which of two materials have large specific surface area and how many times?

6. Gold nanoparticles are known for their catalytic properties. How many Au8 nanoparticles can be obtained from 2.5 cm^3 of metal? The density of gold is 19.3 g/cm^3.

7. A nanoparticle containing 55 gold atoms has a diameter of 1.4 nm. Estimate the radius of gold atom, assuming that atoms in a nanoparticle occupy 70 % of its volume.

8. What will be the melting point of iron powder with a dispersion of 10^7 m^{-1} if the reference iron melting temperature is 1806 K, the surface tension is 2.3 J/m^2, and the heat of fusion is 13.8 kJ / mol?

9. What will be the size of the copper particles if the melting temperature of the copper powder has decreased by 100 degrees compared to the reference? Take thesurface tension of copper 1.43 J / m^2, and the heat of fusion 13.05 kJ / mol.

10. How much has the sodium melting point decreased in comparison to the reference (370.3 K), if after dispersion the average particle size is $5\cdot10^{-7}$ m? Take the surface tension equal to 0.25 J/m^2, and the heat of melting 2.6 kJ/mol.

11. Calculate the melting point of calcium consisting of particles with the dispersion of $2\cdot10^8$ m^{-1}? The heat of melting of calcium is 8.66 kJ/mol, the surface tension equals to 1.4 J/m^2.

Optical phenomena. Ultramicroscopy and electron microscopy.

1. According to Rayleigh's law, calculate the ratio of the intensities of scattered light (J_1/J_2) in two colloidal solutions of the same substance, if the radii of particles in these solutions are following: r_1 = 20 nm and r_2 = 80 nm. Mass concentrations of solutions are the same.

2. Determine the diameter of aerosol particle using the result of the flow ultramicroscopy method: 87 aerosol particles (smoke of open-hearth furnaces) were counted in a volume of $2.2 \cdot 10^{-2}$ mm^3. The concentration of the aerosol is

$c = 10^{-4}$ kg/m^3, the density of particles of the dispersed phase is $\rho = 2$ g/cm^3, the shape of the particles is spherical.

3. Calculate the value of the molar absorption coefficient when light (wavelength 470 nm) passes through the layer of colloidal solution of iron hydroxide with concentration c = 0.1% at the layer thickness of $l = 2.5 \cdot 10^{-3}$ m, Intesity of scattering light is $I_{sc} = 5.9\%$.

4. Calculate the molar coefficient of light absorption when the light (wavelength 470 nm) passes through the layer of the colloidal solution of iron hydroxide of concentrations C = 0.1 %, at different layer thicknesses $l = 2.5 \cdot 10^{-3}$ m.

5. How will the intensity of the scattered light change if the dispersed system, be exposed to light with a wavelength of $\lambda_1 = 530$ nm and $\lambda_2 = 780$ nm? Intensity of scattering light is $I_{sc} = 5.9\%$.

6. The radius of the spherical particles of an oil mist aerosol determined by flow ultramicroscopy is 115 nm. Calculate the amount of mist particles in a volume of $1.5 \cdot 10^{-11}$ m^3 with aerosol concentration of $21 \cdot 10^{-6}$ kg/m^3 and density of 0.92 g/cm^3.

7. The solution of a gold sol with concentration of $5 \cdot 10^{-5}$ kg/m^3 was investigated using the ultramicroscope. The number of particles in the field of view with the area of $1 \cdot 10^{-6}$ m^2 and the light beam depth of $2 \cdot 10^{-2}$ m is 65. Assuming that the gold particles are spherical, calculate their average radius. The density of gold is $19.3 \cdot 10^3$ kg/m^3.

8. The colloidal solution was prepared by dissolving of 10.6 g of the substance in 1 liter of water. The partial concentration of this solution was calculated by the method of flow ultramicroscopy and it equals to $2 \cdot 10^{18}$ particles/L. Calculate the radius of the particles (in m) if their density is 1200 kg/m^3.

9. Determine the radius of particles using the result of the flow ultramicroscopy: 85 particles were counted in a volume of $2.5 \cdot 10^{-2}$ mm^3. The mass concentration is $c = 10^{-4}$ kg/m^3, the density of particles of the dispersed phase is $\rho = 2$ g/cm^3, the shape of the particles is spherical.

10. The sample of silver particles (density is 10.5 g/cm^3) by electron microscopy and adsorption of argon was investigated. It was found that the particles have the form of a disk (low cylinder) with the average diameter of 14

nm and have the specific surface of 128 m^2/g. Calculate the thickness of the particles (the height of the cylinder).

11. The study of the sample of kaolin particles (density 2.5 g/cm^3) by electron microscopy and nitrogen adsorption was carried out. It was revealed that the particles have approximately the shape of the conventional prism with 6-carbon base with an average diameter of the circumscribed circle of 21 nm and have a specific area surface of 248 m^2/g. Calculate the thickness (height) of the particles. (In this problem it is necessary to recall the formula for the region of a regular n-angle s = r·a·n/2, where r is the side length, and a- is the apophema is equal to $r\sqrt{3/2}$ the regular 6-angle.).

Surface phenomena of nanoparticles. Adhesion

1. Calculate the adhesion force of nanoparticles of liquid to the flat surface of the solid material, if the constant of Hamaker A of these two phases, the radius of the particles r and the size of the gap h between the particle and the surface are given in the Table 1:

Table 1

№	a	b	c	d	e	f	g	h	i	j
$A\cdot10^{21}$,J	45	46	47	48	49	35	38	32	43	40
r , nm	15	13	11	9	7	10	12	34	15	8
h , nm	0.172	0.171	0.170	0.169	0.168	0.182	0.175	0.134	0.212	0.253

Stability of nanoparticles

1. Calculate the potential energy U of the interaction of two plane-parallel plates in the aqueous electrolyte solution if the concentration *c*, the value of the diffusion layer potential φ_δ, the relative dielectric constant ε_r and temperature T are given in Table 2. Take the Hamaker constant as A · = 3.0 · 10^{-20} J. The distances *h* between the plates are 2, 5, 10, 15, 25, 50 nm. Plot a graph of dependence of U = f (h).

Table 2

№	Electrolyte	c, mmol/L	T, °C	ε_r	φ_δ, mV
a	$CaCl_2$	1,0	20	80,1	12
b	NaCl	5,0	25	78,3	20
c	K_2SO_4	2,0	15	82,2	32

d	$(NH_4)_2SO_4$	0,5	10	83,8	25
e	Na_3PO_4	0,1	5	85,1	18
f	$Ba(NO_3)_2$	0,3	22	79,2	22
g	CH_3COONa	1,2	20	80,1	33
h	$MgSO_4$	0,8	18	79,3	28
i	$AlCl_3$	1,0	12	83,2	16
j	KBr	1,5	23	79,1	18

2. Calculate the energy U of repulsion of spherical nanoparticles with radius r in the aqueous electrolyte solution with concentration *c* at a potential of diffusion layer φ_δ (see Table 3). Take the temperature 25℃ and the relative dielectric permeability 78.6. Calculate if the distances h between particles: 1, 2, 4, 8, 16, 32 nm. Draw the graph U = *f*(h).

Table 3

№	Electrolyte	C, mmol/L	φ_δ, mV	r , nm
a	NaCl	0,800	30	40
b	Na_2SO_4	0,200	20	10
c	$AlCl_3$	0,100	15	15
d	$MgCl_2$	1,000	18	32
e	KNO_3	1,200	32	40
f	$Al_2 (SO_4)3$	0,300	25	50
g	$Ca(NO_3)_2$	0,500	20	18
h	KBr	1,800	27	25
i	$MgSO_4$	0,400	33	42
j	$AgNO_3$	2,000	18	37

3. Calculate the value of energy of attraction of spherical particles of the polystyrene, if the distance between surfaces of particles in the water medium is 20 nanometers. The radius of particles is 50 nanometers, the Hamaker constant is $A\cdot = 0{,}5 \cdot 10^{-20}$ J.

4. Calculate the total energy of interaction $U=U_{э}+U_{м}$ of two plane-parallel plates which are in water solution of one-one valent electrolyte at value of potential of diffusion layer $\varphi_\delta = 0{,}02$ V. Distance between surfaces of plates is 30 nanometers, $A\cdot = 5 \cdot 10^{-20}$ J, $c_0 = 10^{-4}$ mol/L, T = 273 K, $\varepsilon = 87{,}8$.

5. Calculate the total energy of interaction $U=U_{э}+U_{м}$ of two plane-parallel plates which are in a water solution of one-one valent electrolyte, at value of potential of diffusion layer $\varphi_\delta = 0{,}02$ V. The distance between surfaces of plates is 20 nanometers, $A\cdot = 5 \cdot 10^{-20}$ J, $c_0 = 1{,}5 \cdot 10^{-4}$ mol/L, T = 273 K, $\varepsilon = 87$.

6. Calculate and plot the graph of a potential energy of the interaction of spherical particles of radius r in an aqueous KCl solution with concentration and according to the following data: Hamaker constant $A = 1.5 \cdot 10^{-20}$ J, the diffusion layer potential φ_δ (in Table 4), temperature 20 °C, relative permittivity of a medium 80.1. The values of the interaction energy of particles determine at distances between the surfaces h: 1, 2, 4, 8, 16, 32 nm.

Table 4

№	r, nm	φ_δ, mV	c, mmol/L
a	10	20	1.0
b	20	25	2.0
c	30	15	1.2
d	40	30	2.5
e	50	40	0.5
f	5	10	0.3
g	15	20	1.8
h	25	30	0.6
i	35	15	1.3
j	45	22	0.8

7. Calculate the radius of sulfur hydrosole particles in NaCl aqueous solution (concentration 0.020 mol/L) with the distance between particles h = 10 nm, the energy of electrostatic repulsion will be the same as the repulsion energy of spherical particles of a sulfur sole with a radius 25 nm in KCl aqueous solution of 0.0020 mol/L. Temperature 25°C, the relative dielectric constant 78.38 and the potential of diffusion layer is the same as in both cases.

8. Calculate the interaction energy of the pair of spherical particles of silver hydrosol with the same radius of 32 nm located at the distance between their surfaces h = 10 nm from the following data: the Hamaker constant $A^{\cdot} = 1 \cdot 10^{-19}$ J, the Debye parameter æ= $1 \cdot 10^{8}$ m^{-1}, φ_δ = 40 mV, the relative permittivity ε_r = 80.

9. Calculate and draw the graphical dependence of the energy attraction of spherical nanoparticles placed in an aqueous medium, the distance between the surfaces of particles in the interval from 2 to 20 nm. Constant of Hamaker $2.0 \cdot 10^{-20}$ J. Temperature, the diffusion coefficient of nanoparticles and the viscosity of the medium shown in Table 5.

Table 5

№	T, °C	$D 10^{12}$, m^2/s	h , mP·s
a	10	15.2	1.307
b	20	10.4	1.002

c	2	3.8	1.676
d	30	1.2	0.7977
e	25	2.6	0.893
f	8	25	1.387
g	42	16.7	0.630
h	13	6.3	1.201
i	37	25.2	0.692
j	23	12.3	0.932

10. The diameter of spherical particles of silver hydrosole is 50 nm. Calculate and plot the graphical dependence of attraction energy on the distance between the centers of particles in the range from 55 nm to 100 nm. Take the Hamaker constant as $0.50 \cdot 10^{-20}$ J.

11. Calculate and plot the graphical dependence of the energy of electrostatic attraction between the gold hydrosole particles, whose diameter is 33 nm on the distance between the distance between the centers of spherical particles in the range from 35 nm. to 100 nm. Take the potential of diffusion layer as φ_δ = 15 mV, temperature 20 °C, the relative dielectric permittivity 80,20, and the thickness of the diffuse layer 4,0 nm.

12. The minimum potential energy of interaction for a dispersed system of solid hydrocarbons in water at 25 °C is observed when the distance between particles is 0,20 nm. How many times this energy exceeds the energy of thermal motion, if the particles diameter is 20 nm. Is such a disperse system stable? Take the Hamaker constant as $A^{*} = 9.0 \cdot 10^{-20}$ J. Consider that the depth of the primary potential minimum is determined by the work of the energy of attraction.

Electrokinetic properties of nanoparticles.

1. Calculate the electrophoretic mobility of corundum particles with the radius of 28 nm in NaCl aqueous solution of $1.23 \cdot 10^{-3}$ mol/L at 20 °C if it is known that the bulk rate of electroosmosis of the same solution through porous corundum is $1.38 \cdot 10^{-8}$ m^3/s, the specific electrical conductivity of solution is $1.51 \cdot 10^{-2}$ $Ohm \cdot m^{-1}$, the current strength is 10.77 mA. The relative dielectric permittivity of the solution is 80.2.

2. Determine the required value of electric field at electrophoresis of spherical particles of aluminum sol in ethyl acetate if the electrokinetic potential is 84.0 mV, the relative dielectric permittivity is 6.02, the viscosity is $0.426 \cdot 10^{-3}$ Pa · s, the electrophoresis rate is $3.0 \cdot 10^{-5}$ m/s, the distance between the electrodes is 30 cm.

3. Determine the charge sign and the value of zeta potential of the quartz suspension nanoparticles in water (the thickness of the diffuse layer is much larger than the particle size). During electrophoresis, the particles move to the anode. During the time 3900 s, the observed boundary shifted to a distance of 5.00 cm, an external field voltage gradient is 20.0 V/m, a relative dielectric permittivity is 80.16, a viscosity is 1.002 mPa · s.

4. Electrophoresis of the $Fe(OH)_3$ hydrosol was carried out at a potential difference of 50.0 V at the electrodes and 30.0 cm between the electrodes. The particle movement in 10 minutes was 15.3 mm. Relative dielectric permittivity of water is 80.2, viscosity is 1.00 mPa · s. Calculate the zeta potential of particles under the assumption of the applicability of the Hückel equation.

5. Calculate the zeta potential of iron (III) oxide hydrosol particles with the radius of 8.1 nm when the electrophoretic mobility of $1.42 \cdot 10^{-9}$ $m^2/(V \cdot s)$ was measured in aqueous solution with the ionic strength of 3.3 mmol/L at 25 °C. The viscosity of the dispersion medium is 0.8903 mPa·s, the relative dielectric permittivity is 78.36.

6. The particles of aerosil SiO_2 in aqueous medium at pH = 6.2 have the zeta potential of -30.7 mV. At what distance and to which electrode particles will be displaced in 30 minutes, if the voltage at electrophoresis is 110 V, the distance between electrodes is 25 cm, the relative dielectric permittivity of the dispersion medium is 80.16, the viscosity of the medium is 1.002 mPa · s.

7. Calculate the values of the electrokinetic potential and plot the graph (dependence of ζ on the concentration of potassium chloride from the following data obtained when studying the electroosmosis of an aqueous KCL solution through a porous corundum diaphragm:

C, mmol/L	$æ \cdot 10^2$, $Ohm^{-1}cm^{-1}$	$(V/t) \cdot 10^9$, m^3/s
0.2	0.324	0.750
0.4	0.610	0.500
0.9	1.322	0.250
1.4	2.033	0.125
2.0	2.885	0.050

The relative dielectric constant of 80.16, the viscosity of 1.00 MPa·s, current $1.50 \cdot 10^{-3}$A.

8. Monodisperse polystyrene latex with a particle radius of $4.75 \cdot 10^{-8}$ m reveals an electrophoretic mobility of $1.46 \cdot 10^{-4}$ cm/(V·s) at a temperature of 23

°C and an ionic strength of 0.1 mol. Calculate the zeta potential (viscosity of the dispersion medium is 0.894 mPa·s, the relative dielectric constant is 78.5.

9. Calculate the rate of electrophoresis of aluminum oxide particles in ethanol using the following data: zeta potential is 25 mV; the field strength 900 V/m; the relative dielectric constant is 24.35; the viscosity is $1.087 \cdot 10^{-3}$ Pa·s; particle radius is 300 nm, the Debye parameter i $=1.0 \cdot 10^{7}$ m^{-1}.

10. Calculate the electrophoretic mobility of strontium carbonate particles in water at an electric field strength of 800 V/m, if the zeta potential determined by the electrophoresis rate is 25 mV at 25 ºC (the viscosity is $8.903 \cdot 10^{-4}$ Pa·s, the relative dielectric constant is 78.36). Take the spherical shape of particles with radius of 300 nm, and the ionic strength of the solution correspond to the solubility of $SrCO_3$ in water is $3.05 \cdot 10^{-5}$ mol.

11. Calculate the rate of electroosmosis of a solution of 5 mmol/l KCl through porous corundum, if the zeta potential determined by the speed of electrophoresis of corundum particles in the same solution, 70 mV, is known. The viscosity of the solution is $0.890 \cdot 10^{-3}$ Pa·s, the relative permittivity is 78.4; electric current strength 2.13·10-2 A. The molar electric conductivity of the solution is $1.435 \cdot 10^{-2}$ $Cm \cdot m^{2} \cdot mol^{-1}$.

12. In a capillary made of quartz glass, the potential of flow with -26.0 mV was measured for solution of $1 \cdot 10^{-3}$ mol/L KCl at 25 °C and an overpressure of 150 mmHg. The molar electrical conductivity of the solution is 1.469 10^{-2} $S \cdot m^{2} \cdot mol^{-1}$, the viscosity is 0.89 10^{-3} Pa·s, the relative permittivity is 78.4. Calculate the zeta potential of the glass assuming the surface conductivity to be zero.

Molecular-kinetic properties of nanoparticles

1. Determine the average displacement in 5 s for spherical nanoparticles of Al_2O_3 sol, if the viscosity of medium is equal to 1.002 mPa·s, the temperature is 20 °C, the particle radius is 6.0 nm.

2. The average square displacement of spherical nanoparticles of a silica hydrosol is 12 μm in 4 s. Calculate the radius of the particles if the viscosity of the dispersion medium is 1.00 mPa·s at 20 °C.

3. Determine the mean square displacement of the Al_2O_3 sol nanoparticles on the basis of the following data: the specific surface area of the particles is $1{,}5 \cdot 10^{4}$ m^2/kg, the density of Al_2O_3 is $3.97 g/sm^3$, the viscosity of the dispersion medium

is 1.002 mPa·s, the temperature 20 °C, the observation time is 6 s. Take the shape of particles as spherical.

4. The diffusion coefficient of nanoparticles of platinum sol at 20 °C in acetone is $5{,}1 \cdot 10^{-10}$ m^2/s. Calculate the radius of particles if the viscosity of the medium is 0.32 mPa·s.

5. Determine the diffusion coefficient of spherical iron hydroxide nanoparticles at 17 °C if the diameter equals to 22 nm and the viscosity of the medium is 1.09 cP.

6. The diffusion coefficient of colloidal selenium nanoparticles in water is $1.8 \cdot 10^{-6}$ m^2/day at 20 °C. Assuming they have a spherical shape, calculate the mass of one particle if the density of the dispersed phase is 4.81 g/cm^3, the viscosity of the dispersion medium is $1.002 \cdot 10^{-3}$ Pa·s.

7. Determine the volume of a spherical nanoparticle of platinum, if the diffusion coefficient of these particles in propyl alcohol is $2{,}4 \cdot 10^{-6}$ m^2/day. The temperature is 293 K, the viscosity of the medium is 2.26 cP.

8. The diffusion coefficient of spherical nanoparticles of silica hydrosol is $1.6 \cdot 10^{-6}$ m^2/day at 20 °C, the viscosity of the medium is $1.00 \cdot 10^{-3}$ Pa·s, the silica density is 2.7 g/cm^3. Determine the partial concentration of the silica sol if the mass concentration is 0.500 g/L.

9. The average square displacement of platinum nanoparticles in water in 1 s equals to 3.5 µm. Find the volume of the nanoparticle if the viscosity of the medium is $1.09 \cdot 10^{-3}$ Pa · s at 17 °C. The particles have spherical shape.

10. Determine the coefficient of viscous friction of a spherical particle of gold sol with a diameter of 44 nm in a medium where the viscosity is 1.002 mPa·s (T 20 °C).

11. The average square displacement at the Brownian motion of gold hydrosol nanoparticles in 4 s is $6.89 \cdot 10^{-11}$ m^2. Determine the particle diameter if the viscosity of the dispersion medium is $1.10 \cdot 10^{-3}$ Pa·s at 290 K.

12. According to Svedberg, the average square displacement of gold hydrosol nanoparticles with a radius of 22 nm is 6.6 µm in 3 seconds in water at 20 °C. Calculate the average square displacement for the same time and compare with the experimental data. The viscosity of the medium is $1.002 \cdot 10^{-3}$ Pa·s at this temperature.

13. Compare the coefficient of friction of spherical nanoparticles of platinum sol in acetone and propyl alcohol if in 2 seconds the average square displacement is 5.4 and 2.9 μm, respectively. The viscosity of acetone is $3.2 \cdot 10^{-4}$ Pa·s, the viscosity of propyl alcohol is $22.6 \cdot 10^{-4}$ Pa·s at 20 °C.

14. Calculate the average square displacement at the Brownian motion of the selenium hydrosol nanoparticles in 5 s if the radius of the spherical particles is 35 nm, the medium viscosity is 1.10 cP, the temperature is 17 °C.

15. The average square displacement of nanoparticles of the barium sulfate hydrosol is $1.42 \cdot 10^{-11}$ m^2 when the time of observation is 7 seconds at 20 °C. Determine the mass of the hydrosol particle if the viscosity of the medium is $1.002 \cdot 10^{-3}$ Pa·s. The shape of the particles is spherical, the density of barium sulphate is 4.50 g/cm^3.

Lyophilic self-assembling systems. Micellization

1. Calculate at what interfacial tension the spontaneous dispersion proceeds in a liquid dispersion medium, if the viscosity η equals to 1 mPa·s, the temperature T=20°C, the dispersed phase particles have a spherical shape and their dispersion D =7,14 $10^8 m^{-1}$, the coefficient γ in the Rehbinder-Shchukin equation equals to 15/π.

2. Calculate the value of the critical interfacial tension σ_{cr} at the spontaneous formation of a lyophilic disperse system, if its specific surface $S_{sp} = 6 \cdot 10^8$ m^2/m^3, the temperature T =25 °C, particles have a spherical shape and the coefficient of Rehbinder-Shchukin is equal to 20/π.

3. Calculate the value of the critical interfacial tension σ_{cr} when it is possible a spontaneous dispersion of the phase in a liquid dispersion medium with the viscosity of 1 mPa·s. It is determined that the particles of the dispersed phase have a spherical shape and their average square displacement $\overline{\Delta}$ in time τ = 10 s at 20 °C equals to 9 μm, the coefficient γ in the Rehbinder-Shchukin equation equals to 15/π.

4. Determine the value of the critical interfacial tension σ_{cr} during the formation of a lyophilic disperse system if its specific surface is $S_{sp} = 5.7 \cdot 10^5$ m^2/kg, the temperature T = 20°C, the particles have a spherical shape and their density ρ = 1.05 g/cm^3. Assume that the coefficient γ in the Rehbinder-Shchukin equation equals to 15/π.

5. Calculate the interfacial tension of the spontaneous dispersion of macrophase in water if the viscosity η = 0.89 mPa·s, the temperature T = 25°C, and particles

of spherical shape and their diffusion coefficient D is $2.5 \cdot 10^{-6}$ m^2/day. Assume that the coefficient γ in the Rehbinder-Shchukin equation equals to $20/\pi$.

6. Calculate the critical interfacial tension σ_{cr} during the formation of a lyophilic disperse system. Particles have a spherical shape and the average square displacement $\overline{\Delta}$ in 5 s is 6 µm, the temperature T= 293 K, the viscosity of the dispersion medium η = 1 mPa·s, and the coefficient γ in the Rehbinder- Shchukin equation equals to $20/\pi$.

7. Determine the interfacial tension when the spontaneous dispersion of the phase in a liquid dispersed medium occurs if the viscosity η = 1 mPa·s at 20 °C, particles of the dispersed phase have a spherical shape and the dispersion D is $7.14 \cdot 10^8$ m^{-1}, and the coefficient γ in the Rehbinder- Shchukin equation is $15/\pi$.

8. Determine the surface activity of sodium myristate ($C_{13}H_{27}COONa$) if its CMC's decimal logarithm in the aqueous solution (the surfactant concentration's unit is mol/m^3) is 0,84, micellar solution's surface tension σ_{CMC} = 40,0 mJ/m^2 and the surface tension of water σ_0 = 72,7 mJ/m^2. Calculate the B constant using the equation (10.4) for this surfactant accepting the constant A equaled to 4,63.

9. Determine the number of CH_2-groups in an anionic surfactant molecule, if its CMC's decimal logarithm in the aqueous solution (the surfactant concentration's unit is mol/m^3) is 1.40, A constant in an equation (10.4) equals to 4.63, and B constant equals to 0.290.

10. Determine for the sodium palmitate ($C_{15}H_{31}COONa$) the value of the constant B in the equation (10.4) if CMC of it in the aqueous solution is 1.90 mmol/L and the constant A = 4.63 (the concentration of surfactant expressed in mol/m^3). Calculate the value of CMC for aqueous solutions of sodium myristate ($C_{13}H_{27}COONa$) and sodium stearate ($C_{17}H_{35}COONa$).

11. Determine for the dodecylammonium chloride ($C_{12}H_{25}NH_3Cl$) the value of the constant B in the equation (10.4) if CMC of it in the aqueous solution is $1.5 \cdot 10^{-2}$ mol/L, and constant A = 4.79 (the concentration of surfactant expressed in mol/m^3). Calculate the value of CMC for aqueous solutions of tetradecylammonium chloride ($C_{14}H_{29}$ NH_3Cl) and hexadecylammonium chloride ($C_{16}H_{33}NH_3Cl$).

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