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МЕДИЦИНСКАЯ ХИМИЯ. СБОРНИК ТЕСТОВ

Пособие
для студентов учреждений высшего образования,
обучающихся по специальности «Лечебное дело» на английском языке

MEDICAL CHEMISTRY. COLLECTION OF TESTS

Textbook

УДК 54:61(076.3)
ББК 24.1:5я73=432.1
Т98

Тюлькова, Е. Г.
Т98   Медицинская химия. Сборник тестов : пособие для студентов учреждений высшего образования, обучающихся по специальности «Лечебное дело» на английском языке = Medical chemistry. Collection of tests : textbook / Е. Г. Тюлькова, А. К. Довнар. – Элект. текст. данные (объем 156 Kb). – Гомель : ГомГМУ, 2025. – 50 с. – 1 электрон. опт. диск (CD-ROM). – Систем. требования: IBM-совместимый компьютер; Windows XP и выше; ОЗУ 512 Мб; CD-ROM 8-х и выше. – Загл. с этикетки диска.
ISBN 978-985-588-421-8.

Сборник содержит тестовые задания с ответами по химической термодинамике, кинетике и катализу, растворам электролитов, коллигативным свойствам растворов, гетерогенным равновесиям, окислительно-восстановительным реакциям, электродным и окислительно-восстановительным потенциалам, поверхностным явлениям, дисперсным системам и растворам высокомолекулярных соединений, комплексным соединениям.
Тесты могут быть использованы как для контроля качества усвоения учебного материала, так и для закрепления и систематизации знаний во время лабораторно-практических занятий и самостоятельной работы студентов.
Сборник тестов предназначен для студентов 1-го курса, обучающихся по специальности «Лечебное дело» на английском языке.
Утверждено и рекомендовано к изданию научно-методическим советом учреждения образования «Гомельский государственный медицинский университет» в качестве пособия 20 июня 2024 г., протокол № 9.

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INTRODUCTION

"Medical Chemistry" is an academic discipline of the chemical module which contains systematic scientific knowledge about substances and their transformations accompanied by changes in composition, structure, and properties. This knowledge is necessary to understand the basics of the development of new drugs as well as the physico-chemical methods of qualitative and quantitative analysis of biological fluids, solutions of drugs, and biopolymers.

The purpose of the discipline "Medical Chemistry" is to form basic professional competencies, the basis of which is knowledge of the chemical and physico-chemical foundations of the processes of human vital activity; the use of modern chemical and physico-chemical research methods to study biomedical and medical problems, the creation of new drugs, the determination of the molecular mechanism of their action, analysis the composition of biological fluids, solutions of biopolymers, and medicinal substances.

The structure of the test collection is presented in the following sections: "Chemical thermodynamics", "Solutions", "Chemical kinetics. Catalysis. Chemical equilibrium", "Theory of redox reactions. Electrode and reduction potentials", "Physico-chemistry of surface phenomena. Physico-chemistry of dispersed systems", "Coordination compounds".

1. INTRODUCTION INTO VOLUMETRIC ANALYSIS

Choose one correct variant of answer

1. What values can the equivalence factor of H_3PO_4 take in acid-base reactions?

Variants of answer:

a) 1/2, 1/4, 1/5;

b) 1, 1/5;

c) 1, 2, 3;

d) 1/6, 1/3;

e) 1, 1/2, 1/3.

2. What values can the equivalence factor of H_2SO_4 take in acid-base reactions?

Variants of answer:

a) 1/2;

b) 1/4, 1/5;

c) 1, 1/2;

d) 1, 2;

e) 1/6, 1/3.

3. What values can equivalence factor of $Ba(OH)_2$ take in acid-base reactions?

Variants of answer:

a) 1/2, 1/3;

b) 1/5;

c) 1, 1/6;

d) 1, 1/2;

e) 1/3, 1/4.

4. What is the value of equivalence factor for $KMnO_4$ in permanganatometric titration?

Variants of answer:

a) 1/2;

b) 1/5;

c) 1;

d) 1/3;

e) 1/4.

5. Specify a substance that has the same molar mass and equivalent molar mass.

Variants of answer:

a) Na_2SO_4;

b) H_3PO_4;
c) HCl;
d) $Mg(OH)_2$;
e) H_2S.

6. Specify a substance that has the same molar mass and equivalent molar mass.
Variants of answer:
a) K_2SO_4;
b) H_2SO_4;
c) $NaOH$;
d) $Fe(OH)_2$;
e) K_3PO_4.

7. What reaction is the base of the acid-base titration?
Variants of answer:
a) complexation;
b) redox;
c) neutralization;
d) reaction of formation of hardly soluble substances;
e) hydrolysis.

8. What types of acid-base titration are distinguished?
Variants of answer:
a) permanganatometry and bromatometry;
b) acidimetry and alkalimetry;
c) iodimetry and iodometry;
d) dichromatometry and cerimetry;
e) argentometry and mercurometry.

9. The primary standards for standardization of working solutions (NaOH, KOH) in alkalimetry are…
Variants of answer:
a) CH_3COOH and H_2CO_3;
b) $Na_2B_4O_7 \times 10H_2O$ and $Na_2SO_4 \times 10H_2O$;
c) $H_2C_2O_4 \times 2H_2O$ and $H_2C_4H_4O_4$;
d) $MgCl_2$ and $Zn(NO_3)_2$;
e) HCl and H_2SO_4.

10. The following substances are used as primary standards for standardization of working solutions (HCl, H₂SO₄) in acidimetry:
Variants of answer:
a) $Na_2SO_4 \times 10H_2O$, $NaHCO_3$;
b) KOH, $NaOH$;

c) $H_2C_2O_4\times2H_2O$, $H_2C_4H_4O_4$;

d) Na_2CO_3, K_2S;

e) $Na_2CO_3\times10H_2O$, $Na_2B_4O_7\times10H_2O$.

11. Permanganatometric titration is based on the following half-reaction:

Variants of answer:

a) $MnO_4^- + e^- \rightarrow MnO_4^{2-}$;

b) $MnO_4^- + 2H_2O + 3e^- \rightarrow MnO_2 + 4OH^-$;

c) $Mn^{2+} + 2e^- \rightarrow Mn^0$;

d) $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$;

e) $MnO_2 + 4H^+ + 2e^- \rightarrow Mn^{2+} + 2H_2O$.

12. The following substances are used as primary standards in permanganatometry for standardization of the $KMnO_4$ working solution:

Variants of answer:

a) $Na_2C_2O_4$ and $H_2C_2O_4\times2H_2O$;

b) $Na_2B_4O_7\times10H_2O$ and $NaHCO_3$;

c) $H_2C_2O_4\times2H_2O$ and $H_2C_4H_4O_4$;

d) $K_2Cr_2O_7$ and $KClO_4$;

e) $KBrO_3$ and I_2.

13. Which substance can be determined by both acid-base titration and redox titration?

Variants of answer:

a) calcium nitrate;

b) sodium hydroxide;

c) oxalic acid;

d) ammonium chloride;

e) sulfuric acid.

14. Specify how the titration endpoint is determined in the permanganatometry method?

Variants of answer:

a) by formation of complex compound of indicator with titrant;

b) by changing color of acid-base indicator;

c) by the appearance of pink color of the solution from an excessive drop of titrant;

d) by formation of a slightly soluble compound of indicator with titrant;

e) by the appearance of deep-blue color of the solution from an excessive drop of titrant.

15. In the acid-base titration method, solutions of both substances can be used as titrants that are…

Variants of answer:

a) NH_4OH and KOH;

b) H_2SO_4 and HCOOH;
c) H_3PO_4 and LiOH;
d) NaOH and HCl;
e) H_2SO_3 and NH_4OH.

16. The molarity of sulfuric acid in solution is 5 mol/L. What is the mass of H_2SO_4 (g) contained in 100 mL of this solution?
Variants of answer:
a) 15.8;
b) 5.65;
c) 49.0;
d) 56.1;
e) 9.8?

17. To determine the acidity of dairy products, as working solution can be used as…
Variants of answer:
a) solution of hydrochloric or sulfuric acid;
b) solution of sodium hydroxide or potassium hydroxide;
c) solution of iron (II) hydroxide;
d) solution of phosphoric acid;
e) potassium permanganate aqueous solution.

18. To determine the alkali content in the detergent, as working solution can be used…
Variants of answer:
a) phosphoric acid;
b) sodium or potassium hydroxide;
c) sulfuric or hydrochloric acid;
d) carbonic acid;
e) potassium permanganate or dichromate.

19. In an aqueous solution of which salt the reaction of medium is basic?
Variants of answer:
a) $CaCl_2$;
b) $Al_2(SO_4)_3$;
c) $NaNO_2$;
d) Na_2SO_4;
e) $Mg(NO_3)_2$?

20. In an aqueous solution of which salt the reaction of medium is acidic?
Variants of answer:
a) K_2S;
b) $BiCl_3$;

c) $NaNO_3$;
d) KI;
e) Na_2SO_3?

2. CHEMICAL THERMODYNAMICS

Choose one correct variant of answer

1. When considering a chemical reaction, the term "thermodynamic system" means…
Variants of answer:
a) reagents;
b) products of the reaction;
c) reaction vessel;
d) reagents and reaction products;
e) all solids involved in the reaction.

2. Choose the correct statement.
Variants of answer:
a) kinetic energy is the energy that an object has because of the relative positions or orientations of its components;
b) potential energy is the energy that an object has due to its motion;
c) internal energy is a total energy of a system composed of kinetic and potential energy of all its structural units;
d) work is a measure of the energy that is transferred to or from the system due to temperature differences;
e) the total energy of a system is the amount of energy that can be converted into useful work.

3. An isolated system with the surroundings…
Variants of answer:
a) exchanges energy but not matter;
b) does not exchange either matter or energy;
c) exchanges matter but not energy;
d) exchanges both energy and matter;
e) first it exchanges matter, and then energy.

4. A closed system is a system that…
Variants of answer:
a) exchanges only matter with the surroundings;
b) exchanges matter and energy with the surroundings;

c) does not exchange any energy or matter with the surroundings;
d) exchanges only energy with the surroundings;
e) first exchanges energy, and then matter with the surroundings.

5. Which of the following things is an open system?
Variants of answer:
a) ampoule with medicine;
b) a cup of soup with a lid;
c) a balloon filled with hydrogen;
d) a thermometer;
e) a human being.

6. Which of the following things is a closed system?
Variants of answer:
a) a tree;
b) a cup of coffee that is open to the air;
c) a thermometer;
d) the cat;
e) an open glass of water.

7. The state functions (path independent) include all of the following except of…
Variants of answer:
a) enthalpy;
b) heat;
c) internal energy;
d) Gibbs' free energy;
e) entropy.

8. The First Law of chemical thermodynamics is defined as…
Variants of answer:
a) the entropy of the Universe increases;
b) the total energy of the Universe remains constant;
c) the total energy in the universe is increasing;
d) the total energy in the universe is decreasing;
c) it is impossible to convert all the heat into useful work.

9. Specify the mathematical expression of the First Law of thermodynamics for open systems.
Variants of answer:
a) $\Delta U = 0$;
b) $Q = \Delta U + A$;

c) $S = k \times \ln W$;

d) $\Delta U = Q \pm \mu \times \Delta n - A$;

e) $\Delta G = \Delta H - T \times \Delta S$.

10. A change in which of the following state functions is equal to the heat effect of an isobaric chemical reaction?

Variants of answer:

a) internal energy;

b) Gibbs' free energy;

c) entropy;

d) enthalpy;

e) kinetic energy.

11. One of the important consequences of Hess' Law is the statement that the heat effect of a chemical reaction is equal to…

Variants of answer:

a) the sum of the heats of formation of the reactants;

b) the sum of the heats of formation of the reaction products;

c) the sum of the heats of formation of reaction products minus the sum of the heats of formation of reactants, taking into account the stoichiometric coefficients in the reaction equation;

d) the sum of the heats of formation of reactants minus the sum of the heats of formation of reaction products, taking into account the stoichiometric coefficients in the reaction equation;

e) the sum of the heats of formation of the reactants and reaction products.

12. Point out the endothermic process.

Variants of answer:

a) $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)} + 185$ kJ;

b) $Al_2O_{3(s)} + 3SO_{3(g)} \rightarrow Al_2(SO_4)_{3(s)} + 579$ kJ;

c) $2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)} \Delta_r H^0_{298} = -1200$ kJ;

d) $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ $\Delta_r H^0_{298} = +178$ kJ;

e) $2NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O \Delta_r H^0_{298} = -290$ kJ.

13. More heat is released during the reaction…

Variants of answer:

a) $4NH_{3(g)} + 3O_{2(g)} \rightarrow 2N_{2(g)} + 6H_2O_{(l)}$ $\Delta_r H^0_{298} = -1530$ kJ;

b) $Fe_2O_{3(s)} + 3CO_{(g)} \rightarrow 2Fe_{(s)} + 3CO_{2(g)}$ $\Delta_r H^0_{298} = -26.8$ kJ;

c) $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)} \Delta_r H^0_{298} = +180$ kJ;

d) $C_6H_{12}O_{6(aq)} \rightarrow 2C_2H_5OH_{(l)} + 2CO_{2(g)}$; $\Delta_r H^0_{298} = -314$ kJ;

e) $N_2O_{4(l)} \rightarrow 2NO_{2(g)} - 58,4$ kJ.

14. For the following reaction:

$$CO(g) + 2H_2(g) \rightarrow CH_3OH(g),$$
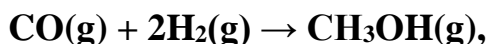
if $\Delta_f H^0_{298}(CO) = -110.5$ kJ/mol and $\Delta_f H^0_{298}(CH_3OH) = -238.7$ kJ/mol, the standard enthalpy change (heat of chemical reaction under standard conditions) is...

Variants of answer:
a) +247.7 kJ;
b) +128.2 kJ;
c) –249.2 kJ;
d) –128.2 kJ;
e) +2.2 kJ.

15. The heat of combustion of graphite and diamond under standard conditions is –393.5 kJ/mol and –395.4 kJ/mol, respectively. The enthalpy change during the transformation of graphite into diamond is...

Variants of answer:
a) –1.9 kJ;
b) +1.9 kJ;
c) graphite cannot be turned into diamond;
d) +788.9 kJ;
e) –788.9 kJ.

16. Entropy is a state function that characterizes...

Variants of answer:
a) the heat losses of the system; the degree of disorder of the system;
b) the heat effect of the reaction, taken with the opposite sign;
c) the ability to do work;
d) heat content of the system;
e) useful work performed by the system or on the system.

17. The entropy of the system increases when...

Variants of answer:
a) water freezes to form ice;
b) substance transforms from a liquid state to a solid state;
c) dissolving NaCl in water;
d) substance transforms from a gas state to a liquid state;
e) dissolving O_2 in water.

18. Which of the following processes leads to a decrease in the entropy of the system?

Variants of answer:
a) dissolution of solid potassium chloride in water;

b) mixing of two gases into one container;
c) freezing of water to form ice;
d) boiling water to form steam;
e) melting of snow with the formation of water.

19. Point out the reaction that occurs with an increase in entropy.
Variants of answer:
a) $2NO_{2(g)} \rightarrow N_2O_{4(g)}$;
b) $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$;
c) $2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$;
d) $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$;
e) $C_2H_{2(g)} + H_{2(g)} \rightarrow C_2H_{4(g)}$.

20. Point out the process for which ΔS will be negative.
Variants of answer:
a) $H_2O_{(s)} \rightarrow H_2O_{(l)}$;
b) $2NH_{3(g)} \leftrightarrow N_{2(g)} + 3H_{2(g)}$;
c) $BaF_{2(s)} \rightarrow Ba^{2+}_{(aq)} + 2F^-_{(aq)}$;
d) $2H_2O_{2(l)} \rightarrow 2H_2O_{(l)} + O_{2(g)}$;
e) $2Hg_{(l)} + O_{2(g)} \rightarrow 2HgO_{(s)}$.

21. Which of the following processes is nonspontaneous?
Variants of answer:
a) rusting (corrosion) of metallic iron;
b) dissolution of salt or sugar in water;
c) photosynthesis;
d) expansion of a gas to fill the available volume;
e) melting of ice at room temperature?

22. The change of which thermodynamic function of state is used as a criterion for the spontaneity of an isobaric-isothermal process?
Variants of answer:
a) enthalpy;
b) entropy;
c) internal energy;
d) Gibbs' free energy;
e) any from listed above.

23. Is it possible for an exothermic reaction to occur spontaneously, for which $\Delta_r S^0_{298} > 0$?
Variants of answer:
a) possible only at low temperatures;

b) the reaction is thermodynamically forbidden;
c) possible at any temperature;
d) possible only at high temperatures;
e) possible only in presence of catalyst.

24. Is it possible for an exothermic reaction to occur spontaneously, for which $\Delta_r S^0_{298} < 0$?
Variants of answer:
a) not possible at any temperature;
b) possible at any temperature;
c) possible only in presence of catalyst;
d) possible only at high temperatures;
e) possible only at low temperatures?

25. For endothermic reaction when a change in entropy is negative, then the reaction is…
Variants of answer:
a) not possible at any temperature;
b) possible at low temperature;
c) possible in presence of catalyst;
d) possible at all temperature;
e) possible at high temperature.

26. The reaction $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$, $\Delta_r H^0_{298} < 0$ is…
Variants of answer:
a) exothermic, proceeds with an increase in entropy;
b) endothermic, proceeds with a decrease in entropy;
c) exothermic, proceeds with a decrease in entropy;
d) endothermic, proceeds with an increase in entropy;
e) spontaneous at any temperature.

27. The chemical equilibrium of the reversible reaction:

$$CH_{4(g)} + 4S_{(s)} \leftrightarrow CS_{2(g)} + 2H_2S_{(g)}, \Delta_r H^0_{298} > 0$$
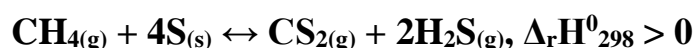
shifts towards the starting substances at…
Variants of answer:
a) an increase in temperature;
b) lowering the pressure;
c) lowering the temperature;
d) the use of a catalyst;
e) an increase in the concentration of methane.

28. The chemical equilibrium of the reversible reaction:

$$N_{2(g)} + 3H_{2(g)} \leftrightarrow 2NH_{3(g)}, \Delta_r H^0_{298} = -92 \text{ kJ}$$

shifts in the forward direction at…

Variants of answer:
a) an increase in temperature;
b) increasing pressure;
c) a decrease in nitrogen concentration;
d) pressure lowering;
e) a decrease in hydrogen concentration.

29. The equilibrium in the following system:

$$C_{(s)} + H_2O_{(g)} \leftrightarrow CO_{(g)} + H_{2(g)}, \Delta_r H^0_{298} > 0$$
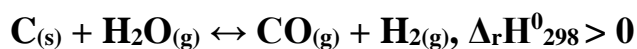
shifts to the right when…

Variants of answer:
a) the pressure increases;
b) a catalyst is used;
c) a decrease in the concentration of carbon (II) oxide;
d) an increase in the concentration of hydrogen;
e) a decrease in temperature.

30. The chemical equilibrium of the reversible reaction:

$$C_{(s)} + CO_{2(g)} \leftrightarrow 2CO_{(g)}, \Delta_r H^0_{298} > 0$$

shifts to the left when…

Variants of answer:
a) a catalyst is used;
b) pressure increases;
c) a decrease in the concentration of CO;
d) an increase in temperature;
e) an increase in CO_2 concentration.

3. THEORY OF REDOX REACTIONS. ELECTRODE AND REDUCTION POTENTIALS

Choose one correct variant of answer

1. Which of the following reactions are related to redox reactions?
Variants of answer:
a) $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$;
b) $4P + 5O_2 \rightarrow 2P_2O_5$;
c) $2KOH + FeSO_4 \rightarrow Fe(OH)_2\downarrow + K_2SO_4$;
d) $ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$;
e) $CaO + H_2SO_4 \rightarrow CaSO_4 + H_2O$.

2. Which of the following electronic equations characterize the reduction process?
Variants of answer:
a) $Zn^0 - 2e^- \rightarrow Zn^{+2}$;
b) $S^0 - 2e^- \rightarrow S^{+2}$;
c) $Fe^{+3} + 1e^- \rightarrow Fe^{+2}$;
d) $Mn^{+2} - 5e^- \rightarrow Mn^{+7}$;
e) $Mg^0 - 2e^- \rightarrow Mg^{+2}$.

3. Which of the following electronic equations characterize the oxidation processes?
Variants of answer:
a) $O_2{}^0 + 2e^- \rightarrow 2O^{-1}$;
b) $2Cl^{-1} - 2e^- \rightarrow Cl_2{}^0$;
c) $N^{+5} + 3e^- \rightarrow N^{+2}$;
d) $Fe^{+3} + 1e^- \rightarrow Fe^{+2}$;
e) $H_2{}^0 + 2e^- \rightarrow 2H^{-1}$.

4. Which of the following substances can exhibit both oxidizing and reducing properties?
Variants of answer:
a) $NaClO_4$;
b) $NaNO_2$;
c) $NaCl$;
d) $NaBr$;
e) KI.

5. Which of the following reactions refer to intermolecular redox reactions?
Variants of answer:
a) $Cl_2 + 2KOH \rightarrow KCl + KClO + H_2O$;

b) $2Fe + 3Cl_2 \rightarrow 2FeCl_3$;
c) $2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$;
d) $2KNO_3 \rightarrow 2KNO_2 + O_2$;
e) $2NaOH + FeSO_4 \rightarrow Fe(OH)_2\downarrow + Na_2SO_4$.

6. The reduction process takes place when…
Variants of answer:
a) neutral atoms turn into negatively charged ions;
b) neutral atoms turn into positively charged ions;
c) the oxidation state of the atom increases;
d) the oxidation state of the atom does not change;
e) neutral atom does not change charge.

7. Only oxidative properties in redox reactions exhibit…
Variants of answer:
a) potassium permanganate;
b) hydrogen sulfide;
c) sodium sulfide;
d) zinc;
e) nitrous acid.

8. What properties does the sulfide ion exhibit in redox reactions?
Variants of answer:
a) reducing agent only;
b) oxidizing agent only;
c) does not exhibit reducing properties;
d) depends on the type of redox reactions;
e) neither an oxidizing nor a reducing agent.

9. Specify the strongest oxidizing agent.
Variants of answer:
a) sulfur;
b) iodine;
c) fluorine;
d) hydrogen;
e) oxygen.

10. In solution sodium nitrite exhibits…
Variants of answer:
a) oxidative properties only;
b) reducing properties only;
c) both oxidative and reducing properties;
d) shows neither oxidative nor reducing properties;
e) most often oxidative properties, less often – reducing properties.

11. Select correct statement.
Variants of answer:

a) the greater the reduction potential, the weaker the oxidizing ability of any substance;

b) quantitative characteristic of the conjugated redox pair is redox potential;

c) dependence of reduction potential values on concentration and temperature is described by periodic Mendeleyev's Law;

d) the higher the value of reduction potential, the stronger the reducing ability of any substance;

e) the lower the reduction potential, the weaker the oxidizing ability of any substance.

12. What is the process of converting nitrite ions to nitrate ions?
Variants of answer:
a) oxidation process;
b) reduction process;
c) proton loss process;
d) neutron loss process;
e) it does not change the number of electrons.

13. What substances can be involved in redox reactions?
Variants of answer:
a) hydrogen sulfide and sulfuric acid;
b) nitric and sulfuric acids;
c) nitric acid and potassium permanganate;
d) potassium oxide and hydrogen chloride;
e) sulfuric acid and calcium oxide.

14. Specify the sum of the coefficients in the equation of chlorine formation in interaction of potassium permanganate with hydrochloric acid.
Variants of answer:
a) 25;
b) 30;
c) 35;
d) 40;
e) 45.

15. Specify the coefficient for the reducing agent in the redox reaction between peroxide hydrogen solution and potassium permanganate solution in sulfuric acid medium.
Variants of answer:
a) 2;
b) 5;

c) 10;
d) 3;
e) 1.

16. Specify the sum of the coefficients in the redox reaction between potassium permanganate solution and potassium sulfite solution in neutral medium.
Variants of answer:
a) 13;
b) 12;
c) 14;
d) 10;
e) 11.

17. Specify the reduction sequence at the cathode of the iron, gold, silver, and tin metal cations contained in the aqueous solution in equal amounts.
Variants of answer:
a) iron – tin – silver – gold;
b) gold – silver – iron – tin;
c) gold – silver – tin – iron;
d) silver – gold – tin – iron;
e) iron – calcium – oxygen – gold.

18. In what cases does the first metal displace the second from the solution of its salt?
Variants of answer:
a) zinc and silver;
b) copper and nickel;
c) iron and magnesium;
d) mercury and zinc;
e) silver and calcium.

19. Between which of substances will a chemical reaction take place in an aqueous solution?
Variants of answer:
a) silver and copper (II) nitrate;
b) lead and zinc sulfate;
c) iron and copper (II) chloride;
d) tin and aluminum chloride;
e) carbon and sulfuric acid.

20. When the galvanic cell operates under standard conditions, the chemical energy of the reagents is converted into…

Variants of answer:
a) electromagnetic;
b) electrical;
c) light;
d) sound;
e) kinetic.

21. Select correct statement.

Variants of answer:
a) the membrane potential appears due to different concentration of ions on both sides of the membrane;
b) diffusion potential does not take place at contact of solutions of different electrolytes;
c) membrane potential results from osmosis;
d) copper-zinc galvanic cell consists of electrodes of second type;
e) the membrane potential appears due to identical concentration of ions on both sides of the membrane.

22. The electrode potential is calculated by the equation of…

Variants of answer:
a) Van't-Hoff;
b) Faraday;
c) Arrhenius;
d) Nernst;
e) Mendeleyev.

23. In electrochemical analysis, electrodes of various designs are widely used. Electrodes of the first type include…

Variants of answer:
a) zinc;
b) silver – silver chloride;
c) copper;
d) gold;
e) oxygen.

24. Electrodes of the second type include…

Variants of answer:
a) silver – silver chloride;
b) hydrogen;
c) zinc;
d) sodium;
e) magnesium.

25. What is the cell diagram of the copper-zinc galvanic cell?
Variants of answer:
a) $Zn^{2+} | Zn | Cu^{2+} | Cu$;
b) $Cu | Cu^{2+} || Zn^{2+} | Zn$;
c) $Zn | Zn^{2+} || Cu^{2+} | Cu$;
d) $Cu^{2+} | Cu || Zn^{2+} | Zn$;
e) $Zn | Zn^{2+} || Ca^{2+} | Ca$.

26. In an electrochemical cell with a cadmium cathode, electrodes can act as an anode under standard conditions with…
Variants of answer:
a) copper;
b) zinc;
c) platinum;
d) mercury;
e) gold.

27. According to the galvanic cell diagram $Cd | Cd^{2+} || Cu^{2+} | Cu$ is characterized in the following way:
Variants of answer:
a) copper electrode is cathode;
b) electrons move from copper electrode to cadmium electrode;
c) oxidation occurs at the copper electrode;
d) the cadmium electrode is the cathode;
e) copper electrode is anode.

28. Which galvanic cell has the greatest electromotive force?
Variants of answer:
a) copper-zinc;
b) copper-silver;
c) copper-iron;
d) silver-zinc;
e) copper-gold.

29. In what direction will electrons move and what is the value of the electromotive force of a galvanic cell consisting of iron and nickel electrodes immersed in solutions of their salts?
Variants of answer:
a) from Fe to Ni; 0.19 V;
b) from Ni to Fe; 0.19 V;
c) from Fe to Ni; –0.19 V;
d) from Fe to Ni; 0.27 V;
e) from Ni to Fe; –0.27 V.

30. The potentiometric method of pH determination is used in the study of medicinal substances. Which of the electrodes can be used as an indicator when measuring the pH of the solution?

Variants of answer:

a) copper;

b) glass;

c) calomel;

d) silver-silver chloride;

e) gold.

4. SOLUTIONS. HETEROGENEOUS EQUILIBRIA. SOLUTIONS OF WEAK AND STRONG ELECTROLYTES. BUFFER SOLUTIONS

Choose one correct variant of answer

1. Solutions are…

Variants of answer:

a) homogeneous systems of variable composition containing at least two components;

b) heterogeneous systems of variable composition;

c) heterogeneous systems of permanent composition;

d) homogeneous systems of permanent composition containing at least two components;

e) microheterogeneous systems separated from the surroundings by an interface surface.

2. An example of a liquid solution is…

Variants of answer:

a) solution of hydrogen in palladium;

b) mixture of hydrogen and nitrogen gases;

c) copper dissolved in gold;

d) air;

e) glucose dissolved in water.

3. Factors affecting the solubility of substances include all of the following, except of…

Variants of answer:

a) nature of solvent and solute;

b) pressure for gases;

c) temperature;

d) pressure for solids;

e) presence of other solutes in a solution.

4. To increase the solubility of a gaseous substance in water, it is necessary to…

Variants of answer:
a) increase the temperature;
b) add HCl to the solution;
c) increase the gas pressure;
d) add a catalyst;
e) add table salt to the solution.

5. The statement that solubility of a gas in a liquid is proportional to its partial pressure above the solution is known as…

Variants of answer:
a) Pauli's principle;
b) Sechenov's equation;
c) Ostwald's dilution Law;
d) Henry's Law;
e) principle of Le Chatelier.

6. Compare K_{sp} for the following salts and specify the salt that has the highest solubility in water.

Variants of answer:
a) $K_{sp}(SrSO_4) = 3.2 \times 10^{-7}$;
b) $K_{sp}(CuS) = 6.3 \times 10^{-36}$;
c) $K_{sp}(CaCO_3) = 4.8 \times 10^{-10}$;
d) $K_{sp}(MnS) = 2.5 \times 10^{-10}$;
e) $K_{sp}(PbCO_3) = 1.0 \times 10^{-13}$.

7. Determine which salt has the lowest solubility in water.

Variants of answer:
a) the solubility product constant of silver (I) nitrite is 0.00016;
b) the solubility product constant of magnesium carbonate is 0.00004;
c) the solubility product constant of calcium sulfate is 0.0000091;
d) the solubility product constant of lithium fluoride is 0.0038;
e) the solubility product constant of silver (I) sulfate is 0.000016.

8. From which solutions does a hardly soluble electrolyte precipitate?

Variants of answer:
a) concentrated;
b) unsaturated;
c) diluted;
d) weak electrolytes;
e) saturated and supersaturated.

9. Total condition of precipitates formation is…
Variants of answer:
a) a large numerical value of K_{sp};
b) $[Cat^+]\times[An^-] = K_S$;
c) $[Cat^+]\times[An^-] < K_S$;
d) $[Cat^+]\times[An^-] \geq K_S$;
e) a small numerical value of K_{sp}.

10. The solubility product constant of lithium fluoride is 0.0038. What is the solubility of this salt?
Variants of answer:
a) 0.0062 mol/L; 0.16 g/L;
b) 1.6 mol/L; 4.16 g/L;
c) 0.031 mol/L; 0.806 g/L;
d) 0.062 mol/L; 1.6 g/L;
e) 0.0019 mol/L; 0.049 g/L.

11. The formula of the major mineral component of the bone tissue is…
Variants of answer:
a) $Ca(H_2PO_4)_2$;
b) $Ca_5(PO_4)_3OH$;
c) $Ca_3(PO_4)_2\times 2H_2O$;
d) $CaHPO_4\times Ca(H_2PO_4)_2$;
e) $CaCO_3$.

12. Colligative (collective) properties of solutions are properties that depend upon the number of solute particles, and not on their nature. They include all of the following except of…
Variants of answer:
a) vapor pressure lowering;
b) diffusion;
c) boiling point elevation;
d) freezing point depression;
e) osmotic pressure.

13. Which solution freezes at the lowest temperature?
Variants of answer:
a) 0.01 M of fructose;
b) 0.01 M potassium sulfate;
c) 0.01 M potassium phosphate;
d) 0.01 M sodium chloride;
e) 0.01 M of glucose.

14. Which solution freezes at the highest temperature?

Variants of answer:

a) 0.1 M of glucose;

c) 0.1 M sodium sulfate;

b) 0.1 M sodium chloride;

d) 0.1 M sodium phosphate;

e) 0.1 M sodium carbonate.

15. Which solution boils at the highest temperature?

Variants of answer:

a) 0.05 M potassium nitrate;

b) 0.05 M potassium sulfide;

c) 0.05 M sucrose;

d) 0.05 M potassium phosphate;

e) 0.05 M potassium bromide.

16. What formula is used to mathematically describe Raoul's ebullioscopic law for electrolytes?

Variants of answer:

a) $\Delta T_f = i \times K_f \times C_m(X)$;

b) $\Delta T_b = i \times K_b \times C_m(X)$;

c) $\Delta T_b = K_b \times C_m(X)$;

d) $\dfrac{P_0 - P}{P_0} = \dfrac{i \times n(X)}{i \times n(X) + n(solvent)}$;

e) $\Delta T_b = K_b \times \dfrac{m(X) \times 1000}{M \times m(solvent)}$.

17. Osmosis is a spontaneous physico-chemical process diffusion of…

Variants of answer:

a) a solute through a semipermeable membrane from a concentrated solution to a dilute one;

b) a solvent through a semipermeable membrane from a concentrated solution to a dilute one;

c) a solvent through a semipermeable membrane from a dilute solution to a concentrated one;

d) solute through a semipermeable membrane from a solution to a pure solvent;

e) a solvent through a semipermeable membrane from a solution to a pure solvent.

18. The osmotic pressure of which solution has maximum value?

Variants of answer:

a) 0.1 M sucrose;

b) 0.2 M of glucose;
c) 0.2 M sodium sulfate;
d) 0.2 M of fructose;
e) 0.2 M of sodium chloride.

19. The osmotic pressure of 1 M glucose solution at 298 K is equal to…
Variants of answer:
a) 1238 kPa;
b) 2476 kPa;
c) 516 kPa;
d) 245 kPa;
e) 4953 kPa.

20. Specify solution that is isotonic with respect to blood.
Variants of answer:
a) 0.9% sodium chloride;
b) 0.9% glucose;
c) 4.5% sodium chloride;
d) 0.9% potassium chloride;
e) 4.5% magnesium chloride.

21. Strong electrolytes include…
Variants of answer:
a) hydrofluoric acid;
b) ammonium hydroxide;
c) carbonic acid;
d) iron (III) acetate;
e) barium hydroxide.

22. Weak electrolytes include…
Variants of answer:
a) nitric acid;
b) aluminum nitrate;
c) calcium hydroxide;
d) nitrous acid;
e) hydrobromic acid.

23. Choose the correct characteristic of weak electrolytes.
Variants of answer:
a) they dissociate completely;
b) they dissociate partially, obey Ostwald's dilution Law;
c) the degree of dissociation is equal to one;

d) they obey Henry's Law;

e) the parameters that are used to describe their dissociation are ionic strength, activity coefficient, activity of ion.

24. Choose the correct characteristic of strong electrolytes.

Variants of answer:

a) they obey Ostwald's dilution Law;

b) the parameters that are used to describe their dissociation are acidity constants, basicity constants, degree of ionization;

c) they dissociate partially;

d) they obey Pauli's principle;

e) they dissociate completely, the degree of dissociation is equal to one.

25. The ionic strength of 0.1 mol/L KBr solution is equal to…

Variants of answer:

a) 0.2 mol/L;

b) 0.3 mol/L;

c) 0.4 mol/L;

d) 0.1 mol/L;

e) 0.15 mol/L.

26. The pH of gastric juice is approximately 1. The molar concentration of hydrogen ions (H^+) in it is…

Variants of answer:

a) 0.01 M;

b) 0.001 M;

c) 0.1 M;

d) 1.0 M;

e) 0.05 M.

27. The pH of an aqueous ammonia solution is 9. The molarity of hydroxyl ions (OH^-) in it is equal to…

Variants of answer:

a) 1×10^{-7} M;

b) 1×10^{-9} M;

c) 1×10^{-6} M;

d) 1×10^{-8} M;

e) 1×10^{-5} M.

28. According to the Brönsted – Lowry's theory, acids are defined as…

Variants of answer:

a) electron donors;

b) proton donors;

c) electron acceptors;

d) proton acceptors;

e) acceptors of electron pair.

29. The types of buffer solutions include all of the following except of…

Variants of answer:

a) weak acid and its salt;

b) weak base and its salt;

c) strong acid and its salt;

d) two acidic salts;

e) acidic salt and neutral salt.

30. Specify which of the following systems can be classified as a buffer system?

Variants of answer:

a) HCl / KCl;

b) NaCl / NaOH;

c) H_2SO_4 / Na_2SO_4;

d) NH_4Cl / NH_4OH;

e) HNO_3 / KNO_3.

5. CHEMICAL KINETICS. CATALYSIS. CHEMICAL EQUILIBRIUM

Choose one correct variant of answer

1. The rate of a chemical reaction depends on the following factors except of…

Variants of answer:

a) the nature of the reagents;

b) concentration of reagents;

c) concentration of products;

d) temperature;

e) the presence of a catalyst.

2. The rate of a homogeneous chemical reaction is…

Variants of answer:

a) the time during which one or more reagents are completely consumed;

b) the time it takes for the reaction to end;

c) change in the concentration of a substance (reagent or reaction product) per unit of time;

d) the amount of the substance of the reaction products at the end of the reaction;

e) change in moles of reactants or products per unit time per unit area of an interface surface.

3. Five minutes after the start of the reaction between CO and O_2, the concentration of CO was 0.6 mol/L. Eight minutes after the start of the reaction, the CO content decreased to 0.35 mol/L. The average rate of this reaction is…

Variants of answer:
a) 0.08 mol/L×min;
b) 0.5 mol/L×min;
c) 0.031 mol/L×min;
d) 0.1 mol/L×min;
e) 0.05 mol/L×min.

4. Most chemical reactions consist of several elementary steps. The number of particles simultaneously participating in elementary step of the reaction is called as…

Variants of answer:
a) the overall reaction order;
b) stoichiometry of the process;
c) molecularity of the reaction;
d) the rate of chemical reaction;
e) order of the reaction by reactant.

5. Specify the correct statement.

Variants of answer:
a) the mechanism of a complex reaction includes only one elementary reaction;
b) the mechanism of a chemical reaction is defined as a number of elementary steps by which reactants are converted into products;
c) all chemical reactions involve several elementary steps;
d) enzymatic reactions involve only one elementary step;
e) the molecularity of an elementary reaction can exceed three.

6. The dependence of the rate of a chemical reaction on the concentration of reactants is described by…

Variants of answer:
a) Gibbs' equation;
b) the Van't-Hoff's rule;

c) Ostwald's dilution Law;
d) the Rate Law;
e) Henry's Law.

7. The overall order of a chemical reaction is…
Variants of answer:
a) the number of molecules involved in the reaction;
b) the mechanism of a chemical reaction;
c) the sum of the coefficients of the reactants in the reaction equation;
d) the sum of the coefficients of the products in the reaction equation;
e) the sum of orders of the reaction by reactants in the kinetic equation.

8. Which of the listed parameters can be positive or negative, integer or fractional as well as zero?
Variants of answer:
a) the rate of homogeneous reaction;
b) the reaction order;
c) the molecularity of the reaction;
d) the rate constant;
e) the rate of heterogeneous reaction?

9. For a simple by mechanism reaction: $A_{(s)} + B_{(g)} \rightarrow AB_{(g)}$ specify the kinetic equation.
Variants of answer:
a) $\upsilon = k \times [A]$;
b) $\upsilon = k \times [A] \times [B]$;
c) $\upsilon = k \times [B]$;
d) $\upsilon = k \times [AB]$;
e) $\upsilon = k \times [A]^2$.

10. For a simple by mechanism reaction: $A_{(g)} + 2B_{(g)} \rightarrow AB_{(l)}$ specify the kinetic equation.
Variants of answer:
a) $\upsilon = k \times [A]$;
b) $\upsilon = k \times [A] \times [B]$;
c) $\upsilon = k \times [B]$;
d) $\upsilon = k$;
e) $\upsilon = k \times [A] \times [B]^2$.

11. Reactions that are simple in mechanism include…
Variants of answer:
a) chain reactions;

b) reversible reactions;
c) conjugated reactions;
d) reactions of radioactive decay;
e) parallel reactions.

12. Reactions that are complex in mechanism include…
Variants of answer:
a) zero-order reactions;
b) consecutive reactions;
c) elimination of drugs from a human body;
d) reactions of radioactive decay;
e) second-order reactions.

13. Specify the Rate Law for zero-order reactions…
Variants of answer:
a) $\upsilon = k_1 \times ([A]_0 - [B]) + k_2 \times ([A]_0 - [C])$;
b) $\upsilon = k \times [A]^0 = k$;
c) $\upsilon = k \times [A]$;
d) $\upsilon = k \times [A]^2$;
e) $\upsilon = k \times [A] \times [B]$.

14. Specify the Rate Law for first-order reactions…
Variants of answer:
a) $\upsilon = k_1 \times [A] - k_2 \times [B]$;
b) $\upsilon = k \times [A]^2$;
c) $\upsilon = k \times [A]^0 = k$;
d) $\upsilon = k \times [A]^x \times [B]^y$;
e) $\upsilon = k \times [A]$.

15. In the system $CO(g) + Cl_2(g) \rightleftarrows COCl_2(g)$, the concentration of CO was increased from 0.03 to 0.12 mol/L, and the concentration of chlorine was increased from 0.02 to 0.06 mol/L. How many times has the rate of direct reaction increased?
Variants of answer:
a) 3 times;
b) 4 times;
c) 12 times;
d) 2 times;
e) 6 times?

16. In the reaction, the scheme of which is as follows:

$$2A_{(g)} + B_{(g)} \rightarrow 3C_{(g)} + B_{(g)},$$
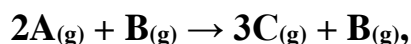
the concentration of substance A was increased 3 times. The reaction rate will…
Variants of answer:
a) increase by 3 times;
b) increase by 9 times;
c) increase by 27 times;
d) decrease by 9 times;
e) increase by 2 times.

17. How many times will the reaction rate of $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$ increase if pressure in system increases 3 times?
Variants of answer:
a) 3 times;
b) the reaction rate does not depend on pressure;
c) 81 times;
d) 9 times;
e) 27 times.

18. A certain first-order reaction is completed by 35% in 50 min at a temperature of 298 K. What is its rate constant?
Variants of answer:
a) 0.086 min^{-1};
b) 0.0037 min^{-1};
c) 0.0086 min^{-1};
d) 0.037 min^{-1};
e) 0,053 min^{-1}.

19. The effect of temperature on the rate of a chemical reaction is described by…
Variants of answer:
a) the kinetic equation;
b) the Michaelis – Menten's equation;
c) the Freundlich's equation;
d) the Gibbs' equation;
e) the Arrhenius' equation.

20. How many times will the reaction rate increase when the temperature rises by 40 K, if the temperature coefficient of the chemical reaction is 2?
Variants of answer:
a) 4 times;
b) 16 times;

c) 10 times;
d) 5 times;
e) 12 times.

21. Temperature coefficient of a reaction is 2. When temperature is increased from 30 to 100°C, rate of the reaction increases by…
Variants of answer:
a) 500 times;
b) 250 times;
c) 128 times;
d) 100 times;
e) 50 times.

22. If with an increase in temperature by 30 K the reaction rate increased by 27 times, the temperature coefficient of the chemical reaction is equal to…
Variants of answer:
a) 8;
b) 4;
c) 2.5;
d) 6;
e) 3.

23. According to one of the theories of chemical kinetics, the formation of a transition complex is a condition necessary for the reaction to proceed. The transition complex is…
Variants of answer:
a) the reagent with the lowest entropy;
b) the product obtained under the influence of radiation;
c) the reagent with the lowest enthalpy of formation;
d) an energetically excited intermediate state between reagents and products, in which chemical bonds in reagent molecules have not broken and new bonds have not formed;
e) the particle with the greatest stability.

24. At what value of the activation energy does the chemical reaction proceed more slowly, all other things being equal?
Variants of answer:
a) 30 kJ/mol;
b) 100 kJ/mol;
c) 90 kJ/mol;
d) 40 kJ/mol;
e) 70 kJ/mol.

25. The activation energy is…

Variants of answer:

a) total energy of reagents and reaction products;

b) the energy that is released as a result of a chemical reaction;

c) the difference between the energies of reagents and reaction products;

d) energy that is absorbed in a chemical reaction;

e) the amount of energy required to reach the transition state and start the reaction.

26. The characteristics of catalysts include all of the following except of…

Variants of answer:

a) catalyst is a substance that changes the rate of reaction by changing the path of the reaction;

b) catalyst initiates a chemical reaction;

c) catalyst is not consumed in the reaction;

d) catalysts can be in solid, liquid or gaseous state;

e) catalysts that increase the rate of a chemical reaction are positive catalysts; catalysts that decrease the rate of reaction are negative catalysts.

27. A positive catalyst increases the rate of a chemical reaction because…

Variants of answer:

a) increases the activation energy of the chemical reaction;

b) lowers the activation energy of the chemical reaction;

c) shifts the equilibrium of the chemical reaction to the right;

d) shifts the equilibrium of the chemical reaction to the left;

e) increases the activation energy barrier.

28. The rate of enzymatic reactions depends on the following factors except of…

Variants of answer:

a) temperature;

b) the presence of inhibitors;

c) atmospheric pressure;

d) pH value of the medium;

e) concentration of substrate.

29. How does temperature affect the rate of enzymatic reactions? Specify the correct answer.

Variants of answer:

a) the reaction rate increases with increasing temperature in any temperature range;

b) the rate of enzymatic reactions does not depend on temperature;

c) enzymes are most active at temperatures of a living organism; at temperatures above 50–60°C they tend to break down and become inactive – the reaction rate drops sharply;

d) when the temperature rises, the rate of the enzymatic reaction always decreases;

e) at a certain temperature, the reaction becomes explosive.

30. The molecular activity of the enzyme shows…
Variants of answer:
a) how many times does the rate of the enzymatic reaction change with an increase in temperature for every 10°C;

b) how many substrate molecules are converted into products in one minute under the influence of one enzyme molecule at 25°C;

c) stability of the enzyme-substrate complex;

d) the activation energy of the enzymatic reaction;

e) overall order of the enzymatic reaction.

6. COORDINATION COMPOUNDS

Choose one correct answer

1. In complex compound $[CoH_2O(NH_3)_4Cl]Cl_2$, the coordination number of the complexing agent is…
Variants of answer:
a) 1;
b) 4;
c) 6;
d) 5;
e) 2.

2. In a complex compound molecule, central atom, usually positively charged, is called as…
Variants of answer:
a) inner sphere;
b) complexing agent;
c) ligand;
d) coordination number;
e) outer sphere.

3. Select the ion of complexing agent in the compound $[Co(NH_3)_5Cl]NO_3$.
Variants of answer:
a) chloride ion;

b) Co^{3+};
c) nitrate ion;
d) Co^{2+};
e) sodium ion.

4. Select the ion of complexing agent in compound K[PtNH₃Cl₅].
Variants of answer:
a) Pt^{2+};
b) NH_3;
c) Pt^{4+};
d) K^+;
e) Ca^{2+}.

5. In a complex compound, the central atom coordinates molecules or ions that surround complexing agent are called as…
Variants of answer:
a) inner sphere;
b) coordination number;
c) ligands;
d) outer sphere;
e) coordination of the number.

6. The formula of complex compound is [Ag(NH₃)₂]Br. Specify ligands.
Variants of answer:
a) Br^-;
b) $[Ag(NH_3)_2]^+$;
c) NH_3;
d) Ag^+;
e) Cl^-.

7. Which ligands are bidentant?
Variants of answer:
a) cyanide ion;
b) NH_3;
c) $H_2N-CH_2-CH_2-NH_2$;
d) H_2O;
e) CO.

8. Specify the formula ammonium tetrachlorodihydroxoplatinate (IV).
Variants of answer:
a) $(NH_4)_2[Pt(OH)_5Cl]$;
b) $(NH_4)_2[Pt(OH)_4Cl_2]$;

c) $(NH_4)_2[Pt(OH)Cl_5]$;

d) $(NH_4)_2[Pt(OH)_2Cl_4]$;

e) $(NH_4)[Pt(OH)_5Cl_{10}]$.

9. Specify the name of complex compound $K[Cr(H_2O)_4F_2]$.

Variants of answer:

a) potassium diaquadifluorochromate (III);

b) trifluorotriaquachrome (III) potassium;

c) tetrafluorodiaquachrome (III) fluoride;

d) potassium tetraaquadifluorochromate (III);

e) tetraaquadifluorochromate (II) potassium.

10. Specify the name of the complex compound $[Pt(NH_3)_4Cl_2](NO_3)_2$.

Variants of answer:

a) dinitrotetrammiplalatinum (IV) chloride;

b) potassium pentachloroammine platinate (IV);

c) tetrachlorodiaminoplatinum (IV);

d) tetramminedichloroplatinum (IV) nitrate;

e) calcium pentachloroammine platinate (IV).

11. Based on the values of the instability constants, determine the most stable complex ion.

Variants of answer:

a) $[Ag(NH_3)_2]^+$ $K_{ins} = 5.89 \times 10^{-8}$;

b) $[Co(NH_3)_6]^{2+}$ $K_{ins} = 4.07 \times 10^{-5}$;

c) $[Ag(CN)_2]^-$ $K_{ins} = 1 \times 10^{-21}$;

d) $[Fe(CN)_6]^{3-}$ $K_{ins} = 1 \times 10^{-31}$;

e) $[Ni(NH_3)_2]^+$ $K_{ins} = 4.59 \times 10^{-6}$.

12. Ligand denticity is…

Variants of answer:

a) the number of σ bonds formed by the ligand with the complexing agent;

b) numerical value of its charge;

c) the total number of atoms of chemical elements included in its composition;

d) the number of atoms in a single ligand that bind to a central atom in a coordination compound;

e) the number of π bonds formed by the ligand with the complexing agent.

13. The coordination number is…

Variants of answer:

a) number of the vacant orbitals located on the external energy level of a central atom;

b) total number of covalent bonds which ligands form with central atom;

c) number of ligands in the inner sphere of a complex ion;

d) the number of ligands associated with the complexing agent multiplied by their denticity;

e) oxidation state of central metal.

14. Cationic complex is…

Variants of answer:

a) $Na[Al(OH)_4]$;

b) $K_3[Fe (CN)_6]$;

c) $[Co(NH_3)_6]Cl_3$;

d) $[Co(NH_3)_3(NO_2)_3]$;

e) $K_4[Fe(CN)_6]$.

15. Anionic complexes are…

Variants of answer:

a) $Na_3[Al(OH)_6]$;

b) $[Ag(NH_3)_2]Cl$;

c) $[Cu(H_2O)_4]SO_4$;

d) $[Ni(NH_3)_4]Cl$;

e) $[Fe(CO)_5]$.

16. Neutral complexes are...

Variants of answer:

a) $[Fe(H_2O)_6]Cl_3$;

b) $Na[Al(OH)_4(H_2O)_2]$;

c) $[Fe(NH_3)_4Cl_2]Cl$;

d) $[Pt(NH_3)_2Cl_2]$;

e) $[Cr(NH_3)_3(H_2O)_3]_{3+}Cl_3$.

17. The mixed complexes are…

Variants of answer:

a) $Na[Co(NH_3)_4]$;

b) $Na[Al(OH)_4(H_2O)_2]$;

c) $[Ag(NH_3)_2]Cl$;

d) $Na_3[Fe(CN)_6]$;

e) $K_4[Fe(CN)_6]$.

18. Determine the correct name for the complex compound $[Ag(NH_3)_2]Cl$.

Variants of answer:

a) diamminesilver (I) chloride;

b) silver diammiacate chloride (I);

c) diammineargentum chloride (I);

d) chlorodiamminoargenate (I);

e) tetraamminecopper (II) sulfate.

19. Determine the correct name for the complex compound $K_4[Fe(CN)_6]$.

Variants of answer:

a) potassium hexacyanoferrate (II);

b) potassium hexacyanoferrate (III);

c) hexacyanide iron (II) potassium;

d) hexacyanidoferrate (II) potassium;

e) hexacyanide iron (III) potassium.

20. Determine the correct name for complex compound $Na[Cr(H_2O)_2F_4]$.

Variants of answer:

a) sodium diaquatetrafluorochromate (II);

b) sodium tetrafluorodiaquachromate (III);

c) sodium tetrafluorodihydroxochromate (III);

d) sodium diaquatetrafluorochromate (III);

e) potassium diaquatetrafluorochromate (II).

21. Determine the correct name for the complex compound $[Co(NH_3)_3Cl_3]$.

Variants of answer:

a) trichlorotriamminecobalt (III);

b) triamminotrichlorocobalt (III);

c) cobalt (III) trichlorotriammiacate;

d) trichlorotriamminecobaltate (III);

e) diamminodichlorocobalt (III).

22. Determine the correct name for the complex compound $[Al(H_2O)_5OH]SO_4$.

Variants of answer:

a) aluminum hydridopentaaquasulfate;

b) pentaaquahyridoaluminate sulfate;

c) hydroxopentaaquaaluminium sulfate;

d) pentaaquahydroxoaluminum sulfate;

e) potassium hydridopentaaquasulfate.

7. PHYSICO-CHEMISTRY OF SURFACE PHENOMENA. PHYSICO-CHEMISTRY OF DISPERSED SYSTEMS. PHYSICO-CHEMISTRY OF BIOPOLYMERS AND THEIR SOLUTIONS

Choose one correct variant of answer

1. The ability of a substance to change the value of surface tension is called as…
Variants of answer:
a) surface concentration;
b) surface energy;
c) surface activity;
d) adsorption;
e) diffusion.

2. When dissolving surfactant in water, the value of surface tension…
Variants of answer:
a) first increases, then decreases;
b) decreases;
c) does not change;
d) increases;
e) first decreases, then increases.

3. Which of the above factors contribute to lowering of the surface tension of water?
Variants of answer:
a) dissolution of inorganic acid;
b) dissolution of the fatty acid salt;
c) pressure increase;
d) temperature decrease;
e) concentration increase.

4. In which series are the formulas of surfactants arranged in the order of increasing their surface activity?
Variants of answer:
a) propanol, butanol, amyl alcohol;
b) acetic acid, water, butyric acid;
c) butyric acid, propionic acid, acetic acid;
d) glucose, valeric acid, acetic acid;
e) sucrose, acetic acid, nitric acid.

5. In aqueous solution, the surface activity of pentanol compared with the surface activity of hexanol is…

Variants of answer:
a) more approximately 3 times;
b) less approximately 3 times;
c) almost the same;
d) less approximately 6 times;
e) more approximately 6 times.

6. Surfactants include water-soluble…

Variants of answer:
a) oxides;
b) carbohydrates;
c) organic acids;
d) inorganic acids;
e) bases.

7. The equation used for experimental determination of adsorption at a fixed interface is…

Variants of answer:
a) Shishkovsky equation;
b) Gibbs equation;
c) Langmuir equation;
d) Nernst equation;
e) Arrhenius equation.

8. The type of adsorption of strong electrolytes from aqueous solutions is…

Variants of answer:
a) selective;
b) molecular;
c) atom exchange;
d) distribution;
e) diffusion.

9. Method for preparing colloidal solutions is…

Variants of answer:
a) condensation;
b) electrophoresis;
c) osmosis;
d) sedimentation;
e) polymerization.

10. The molecular kinetic properties of sols include…

Variants of answer:
a) Brownian motion;
b) electrophoresis;
c) peptization;
d) diffusion;
e) condensation.

11. The reason for electrokinetic phenomena of colloidal solutions is the presence at the interface surface of solid and liquid phases of…

Variants of answer:
a) hydrate shell;
b) increased pressure;
c) layers with high viscosity;
d) double electric layer;
e) decreased temperature.

12. What are the names of electrolyte ions that adsorb directly on a solid surface and give it an electric charge?

Variants of answer:
a) cations;
b) anions;
c) potential determining ions;
d) counter ions of the adsorption layer;
e) counter ions of the diffusion layer.

13. The aqueous sodium sulfide solution was added to an excess of copper (II) nitrate solution and was obtained a colloidal solution. What ions are adsorbed around the aggregate?

Variants of answer:
a) copper (II) cations;
b) sodium cations;
c) sulfate ions;
d) nitrate ions;
e) sulfite ions.

14. The aqueous hydrogen sulfide solution was added to an excess of an aqueous zinc chloride solution to obtain a colloidal solution. What ions are adsorbed around the aggregate?

Variants of answer:
a) zinc cations;
b) hydrogen cations;
c) chloride ions;

d) hydrosulfide ions;

e) copper ions.

15. A solution of sodium chloride was added to the aqueous solution of excess silver (I) nitrate to obtain a colloidal solution. What ions added to the solution can cause coagulation of the resulting solution?

Variants of answer:

a) sulfate ions;

b) silver (I) cations;

c) gold ions;

d) aluminum cations;

e) hydrosulfide ions.

16. Coagulation of solutions by electrolytes occurs due to…

Variants of answer:

a) increasing electric charge;

b) decreasing electric charge;

c) increasing rate of Brownian motion rate of particles of dispersed phase;

d) increasing the electrokinetic potential;

e) decreasing kinetic energy.

17. Specify the cation with the greatest coagulant effect.

Variants of answer:

a) potassium;

b) calcium;

c) aluminum;

d) magnesium;

e) sodium.

18. Hydrophobic solutions differ from solutions of high molecular weight compounds by…

Variants of answer:

a) thermodynamic instability;

b) particle size of dispersed phase;

c) chemical properties;

d) direction of movement of particles during electrophoresis;

e) temperature level.

19. The synthetic polymer is…

Variants of answer:

a) cellulose;

b) starch;

c) protein;

d) teflon;
e) glucose.

20. Product of polycondensation reaction is…
Variants of answer:
a) teflon;
b) rubber;
c) nylon;
d) polyvinyl chloride;
e) starch.

21. How does the process of unlimited swelling of the polymer end?
Variants of answer:
a) formation of a two-phase system;
b) emulsion formation;
c) solution formation;
d) formation of suspension;
e) precipitation formation.

22. High molecular compounds solutions are…
Variants of answer:
a) homogeneous systems;
b) heterogeneous systems;
c) gaseous systems;
d) lyophobic systems;
e) liquid systems.

23. The charge of the ampholyte macromolecule depends on…
Variants of answer:
a) carboxyl group numbers;
b) numbers of hydroxyl groups;
c) number of molecule;
d) molecular weight;
e) ion charge.

24. The isoelectric point is one of the most important characteristics of the protein. In the isoelectric state protein has…
Variants of answer:
a) zero electrophoretic mobility;
b) maximum degree of swelling;
c) minimum degree of coagulation;
d) maximum solubility in water;
e) maximum oxidation state.

25. At what pH values is electrophoretic separation possible between a mixture of two proteins whose isoelectric points are respectively 5 and 8?

Variants of answer:

a) from 1 to 5;

b) from 5 to 8;

c) from 8 to 10;

d) from 3 to 7;

e) from 10 to 12.

26. The isoelectric point of muscle myosin is 5. Its swelling percent is minimum at…

Variants of answer:

a) $pH = 2$;

b) $pH = 4$;

c) $pH = 5$;

d) $pH = 7$;

e) $pH = 1$.

27. Specify the correct statement.

Variants of answer:

a) a colloidal solution can be prepared by NaCl dissolution in water;

b) a dispersed system is a micro heterogeneous system composed of microscopic particles of a dispersed phase distributed in a dispersion medium;

c) a colloidal solution is a single-phase system of variable composition;

d) a colloidal solution is thermodynamically unstable;

e) a colloidal solution can be prepared by $FeCl_2$ dissolution in water.

28. Specify the aerosol.

Variants of answer:

a) fog;

b) chocolate;

c) peptide;

d) water solution;

e) cupper.

29. Specify the emulsion.

Variants of answer:

a) bread;

b) skin;

c) milk;

d) rain;

e) wind.

30. Specify the method of dispersed systems preparing.

Variants of answer:
a) peptization;
b) electrophoresis;
c) osmosis;
d) polimerization;
e) diffusion.

ANSWERS

1. Introduction into volumetric analysis

№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers
1	e	5	c	9	c	13	c	17	b
2	c	6	c	10	e	14	c	18	c
3	d	7	c	11	d	15	d	19	c
4	b	8	b	12	a	16	c	20	b

2. Chemical Thermodynamics

№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers
1	d	7	b	13	a	19	d	25	a
2	c	8	b	14	d	20	e	26	c
3	b	9	d	15	b	21	c	27	c
4	d	10	d	16	a	22	d	28	b
5	e	11	c	17	c	23	c	29	c
6	c	12	d	18	c	24	e	30	b

3. Theory of redox reactions. Electrode and reduction potentials

№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers
1	b	7	a	13	a	19	c	25	c
2	c	8	a	14	c	20	b	26	b
3	b	9	c	15	b	21	a	27	a
4	b	10	c	16	a	22	d	28	d
5	b	11	b	17	c	23	a	29	a
6	a	12	a	18	a	24	a	30	b

4. Solutions. Heterogeneous equilibria.
Solutions of weak and strong electrolytes. Buffer solutions

№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers
1	a	7	c	13	c	19	b	25	d
2	e	8	e	14	a	20	a	26	c
3	d	9	d	15	d	21	e	27	e
4	c	10	d	16	b	22	d	28	b
5	d	11	b	17	c	23	b	29	c
6	a	12	b	18	c	24	e	30	d

5. Chemical Kinetics. Catalysis. Chemical Equilibrium

№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers
1	c	7	e	13	b	19	e	25	e
2	c	8	b	14	e	20	b	26	b
3	e	9	c	15	c	21	c	27	b
4	c	10	e	16	b	22	e	28	c
5	b	11	d	17	e	23	d	29	c
6	d	12	b	18	c	24	b	30	b

6. Coordination compounds

№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers
1	c	6	c	11	d	15	a	19	a
2	b	7	c	12	d	16	d	20	d
3	d	8	d	13	b	17	b	21	b
4	c	9	d	14	c	18	a	22	d
5	c	10	d						

7. Physico-chemistry of surface phenomena. Physico-chemistry of dispersed systems. Physico-chemistry of biopolymers and their solutions

№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers	№ question	Correct answers
1	c	7	c	13	a	19	d	25	b
2	b	8	a	14	a	20	c	26	c
3	b	9	a	15	a	21	c	27	b
4	a	10	a	16	b	22	a	28	a
5	b	11	d	17	c	23	a	29	c
6	c	12	c	18	a	24	a	30	a

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