

PHYSICAL PROPERTIES AND UNITS OF MEASUREMENT

1. If n-hexane boils at 68°C, calculate the boiling temperature of the specified compound in Kelvin degrees (K = Kelvin).
 - 1) 241 K;
 - 2) 341 K;
 - 3) 273 K;
 - 4) 205 K;
 - 5) 68 K.
2. How many cubic meters are 750 mm³?
 - 1) $7,5 \cdot 10^{-9}$ m³;
 - 2) $7,5 \cdot 10^{-6}$ m³;
 - 3) $7,5 \cdot 10^{-5}$ m³;
 - 4) $7,5 \cdot 10^{-7}$ m³;
 - 5) 0,75 m³.
3. Find the derived SI unit.
 - 1) Hertz (Hz);
 - 2) Meter (m);
 - 3) Second (s);
 - 4) Ampere (A);
 - 5) Candela (cd).
4. Hydrochloric acid (HCl) with the percentage concentration of 36.5% has a density of 1.18 g/cm³. Express the density of the acid in the form of (g/dm³).
 - 1) $1,18 \cdot 10^{-3}$ g/dm³;
 - 2) $1,18 \cdot 10^3$ g/dm³;
 - 3) $1,18 \cdot 10^6$ g/dm³;
 - 4) $1,18 \cdot 10^2$ g/dm³;
 - 5) $1,18 \cdot 10^{-6}$ g/dm³.

MATTER. ATOM STRUCTURE

1. A saturated solution of sodium chloride in water contains 2.1 g of salt in the form of a precipitate. What is the most convenient way to quantitatively separate the precipitate from the previously mentioned mixture?
 - 1) Filtration;
 - 2) Decanting;
 - 3) Sedimentation;
 - 4) Extraction;
 - 5) Mixing.

2. At the moment when the solvent vapor pressure above the solution is equalized with the external pressure during the solution heating, there occurs a phenomenon called:
 - 1) evaporation;
 - 2) deposition;
 - 3) melting;
 - 4) boiling;
 - 5) sublimation.

3. Calculate the number of neutrons in the nucleus of sodium ions Na^+ if we know that the atomic number of atom is 11, and the mass number is 23.
 - 1) 10;
 - 2) 11;
 - 3) 23;
 - 4) 12;
 - 5) 13.

4. On the basis of the electronic configurations of atoms of individual elements, draw a conclusion which atom has the highest value of ionization energy.
 - 1) $1s^2 2s^2 2p^6 3s^1$;
 - 2) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$;
 - 3) $1s^2 2s^2 2p^6 3s^2 3p^5$;
 - 4) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$;
 - 5) $1s^2 2s^2 2p^6 3s^2 3p^4$.

5. Find orbitals that are characterized by the major quantum number $n = 3$ and the secondary quantum number $l = 2$.
 - 1) 3p- orbitals;
 - 2) 3s- orbital;
 - 3) 3d- orbitals;
 - 4) 4f- orbitals;
 - 5) 2s- orbital.

CHEMICAL BOND

1. Durin the formation of a polar covalent bond between a hydrogen atom and a chlorine atom in a hydrogen chloride molecule, the following orbitals overlap: (${}_1\text{H}$ and ${}_{17}\text{Cl}$)
 - 1) 1s H and 3p Cl;
 - 2) 1s H and 3s Cl;
 - 3) 1s H and 2s Cl;
 - 4) 1s H and 2p Cl;
 - 5) 2s H and 3p Cl.

2. Calculate the order of the bond in the O_2 molecule if it is known that the order number of oxygen atom is 8 (sO).
 - 1) 1,5;
 - 2) 3;
 - 3) 2;
 - 4) 2,5;
 - 5) 1.

3. Based on the value of electronegativity of individual elements, predict in which case the bond with the most expressed covalent character is formed. $\chi(Li) = 1$; $\chi(Cl) = 3$; $\chi(H) = 2,1$; $\chi(Mg) = 1,2$; $\chi(O) = 3,5$; $\chi(F) = 4$; $\chi(Na) = 0,9$; $\chi(Br) = 2,8$.
 - 1) LiCl;
 - 2) HCl;
 - 3) MgO;
 - 4) HF;
 - 5) NaBr.

4. Which bond is cleaved by the dissociation of a complex compound $[Ag(NH_3)_2]Cl$?
 - 1) Coordinate-covalent bond;
 - 2) Metal connection;
 - 3) Ionic bond;
 - 4) Covalent bond;
 - 5) Hydrogen bond.

5. Find the TRUE statement:
 - 6) Molecules with unpaired electrons in molecular orbitals are called diamagnetic molecules;
 - 7) The carbon atoms in the ethane molecule are sp^2 -hybridized;
 - 8) The boron atom in the BCl_3 molecule is sp^3 -hybridized;
 - 9) The formation of the π -bond is performed by overlapping one s-orbital and one sp-hybridized atomic orbital;
 - 10) The metal of the crystal lattice can be: body-centered cubic (Li), surface-centered cubic (Cu) as well as a hexagonal (Zn).

BASIC CHEMICAL LAWS

1. Which of the above-mentioned examples is not possible to illustrate the law of multiple proportions.
 - 1) Water and hydrogen peroxide;
 - 2) Sulfur dioxide and sulfur trioxide;
 - 3) Nitrogen(I)-oxide, nitrogen(II)-oxide, nitrogen(III)-oxide, nitrogen(IV)-oxide, nitrogen(V)-oxide;
 - 4) Water and methane;
 - 5) Carbon monoxide and carbon dioxide.

2. In which the weight ratio carbon and oxygen were combined in the molecule of the carbon(IV)-oxide?
 $A_r(C) = 12$; $A_r(O) = 16$.
- 1) 3:8;
 - 2) 1:2;
 - 3) 2:1;
 - 4) 3:4;
 - 5) 12:16.
3. What is the volume of 1 mole of oxygen at a temperature of 0°C and pressure of 101,325 kPa?
- 1) 32 cm^3 ;
 - 2) $22,4\text{ dm}^3$;
 - 3) 224 cm^3 ;
 - 4) 16 g;
 - 5) $22,4\text{ m}^3$.
4. Find the empirical formula of a compound consisting of: 58.82% of carbon, 9.80% of hydrogen and 31.37% of oxygen. $A_r(C) = 12$; $A_r(H) = 1$; $A_r(O) = 16$.
- 1) CHO;
 - 2) $\text{C}_5\text{H}_{10}\text{O}_2$;
 - 3) C_5H_{10} ;
 - 4) C_5O_2 ;
 - 5) $\text{C}_2\text{H}_{10}\text{O}_5$.
5. Calculate the percentage of sulfur in copper(II)-sulfate pentahydrate. $A_r(\text{Cu}) = 63,55$; $A_r(\text{S}) = 32$; $A_r(\text{O}) = 16$; $A_r(\text{H}) = 1$.
- 1) 12,82%;
 - 2) 87,18%;
 - 3) 20,06%;
 - 4) 79,94%;
 - 5) 32%.

CHEMICAL REACTIONS. CALCULATIONS BASED ON CHEMICAL EQUATIONS

1. What is the mass of 0.72 mol of sulfur(IV)-oxide (SO_2)? $A_r(\text{S}) = 32$; $A_r(\text{O}) = 16$.
- 1) 46,08 g;
 - 2) 46,08 mg;
 - 3) 46,08 kg;
 - 4) 34,56 g;
 - 5) 54 g.

2. $1,08 \cdot 10^{24}$ oxygen atoms are found in:
(Ar(H) = 1; Ar(O) = 16; Ar(S) = 32; Ar(Hg) = 200; Ar(C) = 12; Ar(N) = 14.)
- 1) 11,2 dm³ gas CO₂;
 - 2) 0,15 mols HNO₃;
 - 3) $3,6 \cdot 10^{23}$ molecule of H₂O;
 - 4) 44,1 g H₂SO₄;
 - 5) 10 g HgO.
3. Calculate the mass (g) of carbonic acid containing the same number of molecules as $1,8 \cdot 10^{-3}$ dm³ of water at room temperature. Ar(H) = 1; Ar(C) = 12; Ar(O) = 16.
- 1) 0,0498;
 - 2) 1,8;
 - 3) 0,62;
 - 4) 0,018;
 - 5) 6,2.
4. How many oxygen atoms are in 31.5 g of nitric acid? Ar(H) = 1; Ar(N) = 14; Ar(O) = 16.
- 1) $9 \cdot 10^{23}$;
 - 2) $6 \cdot 10^{23}$;
 - 3) $9 \cdot 10^{-23}$;
 - 4) $3 \cdot 10^{23}$;
 - 5) $6 \cdot 10^{-23}$.
5. What is the volume (dm³) of $3,6 \cdot 10^{23}$ molecules of carbon(IV)-oxide? (Measurements were performed under the normal conditions).
- 1) 1344;
 - 2) 1,344;
 - 3) 22,4;
 - 4) 13,44;
 - 5) 134,4.

ENERGY CHANGES IN CHEMICAL REACTIONS (THERMOCHEMISTRY)

1. The thermal content of substances is called enthalpy, and is denoted by:
- 1) G;
 - 2) S;
 - 3) A;
 - 4) H;
 - 5) T.

2. How much energy is released during the reaction of 5.4 g of aluminum?
 $\text{Fe}_2\text{O}_3(\text{s}) + 2 \text{Al}(\text{s}) \rightarrow \text{Al}_2\text{O}_3(\text{s}) + 2\text{Fe}(\text{s}) \quad \Delta_r H = - 847,8 \text{ kJ/mol}$
 $\text{Ar}(\text{Al}) = 27; \text{Ar}(\text{Fe}) = 56; \text{Ar}(\text{O}) = 16.$
- 1) - 84,78 kJ;
 - 2) 84,78 kJ;
 - 3) -169,59 kJ;
 - 4) 169,59 kJ;
 - 5) - 8,478 kJ.
3. In which case, the system is in equilibrium?
- 1) $\Delta G < 0;$
 - 2) $\Delta S < 0;$
 - 3) $\Delta H = 0;$
 - 4) $\Delta G = 0;$
 - 5) $\Delta S < \Delta H/T.$
4. In which case, the entropy of the system decreases, ie. $\Delta S < 0$?
- 1) Evaporation of liquids;
 - 2) Iodine sublimation;
 - 3) Ice Melting;
 - 4) Combining of mercury and oxygen with formation of mercury(II)-oxide;
 - 5) Thermal decomposition of potassium chlorate.
5. Calculate the standard enthalpy of ethanol formation based on the following data and the stated chemical reaction:
 $\Delta_f H(\text{CO}_2) = -393,5 \text{ kJ/mol}; \Delta_f H(\text{H}_2\text{O}) = -285,8 \text{ kJ/mol}$
 $\text{C}_2\text{H}_5\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow 2 \text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l}) \quad \Delta_r H = - 1366,8 \text{ kJ/mol}$
- 1) 277,6 kJ/mol;
 - 2) -277,6 kJ/mol;
 - 3) 393,5 kJ/mol;
 - 4) 285,8 kJ/mol;
 - 5) 1316,8 kJ/mol.

CHEMICAL REACTION RATE. EQUILIBRIUM

1. Find the correctly written expression for the rate of a chemical reaction based on the law of mass action for the next chemical reaction $2 \text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g}).$
- 1) $v = k \cdot [\text{NO}] \cdot [\text{O}_2];$
 - 2) $v = k \cdot [\text{NO}_2];$
 - 3) $v = k \cdot [\text{NO}_2]^2;$
 - 4) $v = k \cdot [\text{NO}]^2 \cdot [\text{O}_2]^2;$
 - 5) $v = k \cdot [\text{NO}]^2 \cdot [\text{O}_2].$

2. How will the value of the rate of direct chemical reaction change if the concentration of reactants increases three times?



- 1) the rate will not change;
 - 2) the rate is increased three times;
 - 3) the rate is reduced three times;
 - 4) the rate is increased nine times;
 - 5) the rate is reduced nine times.
3. Hydrogen peroxide decomposes spontaneously into water and oxygen in the presence of manganese-dioxide. Manganese-dioxide for this chemical reaction is:
- 1) reactant;
 - 2) reaction product;
 - 3) activated complex;
 - 4) catalyst;
 - 5) inhibitor.
4. How does the reaction rate $\text{A(aq)} + 3\text{B(aq)} \rightarrow 2\text{C(aq)}$ change if the concentration of reactant A increases twice and the concentration of reactant B decreases twice?
- 1) The reaction rate is increased four times;
 - 2) The reaction rate will not change;
 - 3) The reaction rate is reduced four times;
 - 4) The reaction rate is doubled;
 - 5) The reaction rate is reduced twice.
5. How will the position of equilibrium of the system $2 \text{HI(g)} \rightleftharpoons \text{H}_2\text{(g)} + \text{I}_2\text{(g)}$ be affected by the increase of pressure?
- 1) The equilibrium shifts to the right;
 - 2) The equilibrium shifts to the left;
 - 3) The specified change will not affect the equilibrium position;
 - 4) The equilibrium shifts in the direction of the decomposition of hydrogen iodide;
 - 5) The equilibrium shifts in the direction of hydrogen iodide formation.
6. Calculate the equilibrium constant of the following reaction: $\text{CO(g)} + 2\text{H}_2\text{(g)} \rightleftharpoons \text{CH}_3\text{OH(g)}$ if the equilibrium concentration for CO is 0,1 mol/dm³, for H₂ 0,3 mol/dm³ and for CH₃OH is 0,45 mol/dm³.
- 1) 5;
 - 2) 0,5;
 - 3) 15;
 - 4) 1,5;
 - 5) 50.

OXIDO-REDUCTION REACTIONS

- Find the accurate statement:
 - Hydrogen in its compounds always has the oxidation state of +1;
 - Alkali metals can also have negative oxidation states;
 - Fluorine most often occurs in its compounds with the oxidation state -1, but it also occurs often with positive oxidation states;
 - The algebraic sum of the oxidation numbers of the elements in the molecule is zero;
 - The algebraic sum of the oxidation numbers of the elements in a complex ion is equal to zero.
- Determine the coefficients of the following chemical reaction:
 $\text{HNO}_3 + \text{Ag}_2\text{S} \rightarrow \text{AgNO}_3 + \text{NO}_2 + \text{S} + \text{H}_2\text{O}$
 - $\text{HNO}_3 + \text{Ag}_2\text{S} \rightarrow 2\text{AgNO}_3 + \text{NO}_2 + \text{S} + \text{H}_2\text{O}$;
 - $2\text{HNO}_3 + \text{Ag}_2\text{S} \rightarrow \text{AgNO}_3 + \text{NO}_2 + \text{S} + \text{H}_2\text{O}$;
 - $\text{HNO}_3 + \text{Ag}_2\text{S} \rightarrow 2\text{AgNO}_3 + 2\text{NO}_2 + \text{S} + \text{H}_2\text{O}$;
 - $4\text{HNO}_3 + \text{Ag}_2\text{S} \rightarrow \text{AgNO}_3 + 2\text{NO}_2 + \text{S} + \text{H}_2\text{O}$;
 - $4\text{HNO}_3 + \text{Ag}_2\text{S} \rightarrow 2\text{AgNO}_3 + 2\text{NO}_2 + \text{S} + 2\text{H}_2\text{O}$.
- Which compound acts as a reducing agent only?
 - HNO_2 ;
 - H_2SO_3 ;
 - H_2S ;
 - SO_3 ;
 - MnO_2 .
- Find the reaction in which the oxidation of chlorine occurred.
 - $\text{SnCl}_2 + \text{Cl}_2 \rightarrow \text{SnCl}_4$;
 - $\text{NaCl} + \text{AgNO}_3 \rightarrow \text{AgCl} + \text{NaNO}_3$;
 - $\text{MnO}_2 + 4\text{HCl} \rightarrow \text{Cl}_2 + \text{MnCl}_2 + 2\text{H}_2\text{O}$;
 - $\text{HClO} \rightarrow \text{HCl} + \text{O}$;
 - $\text{KIO}_3 + 5\text{KI} + 6\text{HCl} \rightarrow 6\text{KCl} + 3\text{I}_2 + 3\text{H}_2\text{O}$.
- How many grams of (g) ammonium-dichromate are needed in order to obtain 30 mmol of chromium (III) oxide by the reaction of decomposition? $\text{Ar}(\text{N}) = 14$; $\text{Ar}(\text{H}) = 1$; $\text{Ar}(\text{Cr}) = 52$; $\text{Ar}(\text{O}) = 16$.
 - 4,56;
 - 7,56;
 - 45,6;
 - 75,6;
 - 456.
- How many moles (mol) of the oxidizing agent are needed to obtain $1,2 \cdot 10^{20}$ chlorine atoms in the reaction of potassium-permanganate and hydrochloric acid?
 - $4 \cdot 10^3$;
 - $0,4 \cdot 10^{-2}$;
 - $4 \cdot 10^{-5}$;
 - 10^{-3} ;
 - 10^{-4} .

ION (IONIC) REACTIONS

1. Show the reaction of aluminum-chloride and sodium-hydroxide in the ionic form.
 - 1) $\text{AlCl}_3 + 3\text{NaOH} \rightarrow \text{Al(OH)}_3 + 3\text{NaCl}$;
 - 2) $\text{Al}^{3+} + 3\text{Cl}^- + 3\text{Na}^+ + 3\text{OH}^- \rightarrow \text{Al(OH)}_3 + 3\text{Na}^+ + 3\text{Cl}^-$;
 - 3) $\text{Al}^{3+} + 3\text{Cl}^- + \text{Na}^+ + \text{OH}^- \rightarrow \text{Al}^{3+} + 3\text{OH}^- + \text{Na}^+ + 3\text{Cl}^-$;
 - 4) $\text{AlCl}_3 + \text{Na}^+ + \text{OH}^- \rightarrow \text{Al(OH)}_3 + \text{Na}^+ + \text{Cl}^-$;
 - 5) $\text{Al}^{3+} + 3\text{Cl}^- + 3\text{NaOH} \rightarrow \text{Al(OH)}_3 + 3\text{Na}^+ + 3\text{Cl}^-$.
2. Find the compound that should be written in the form of molecule in ionic reactions.
 - 1) HBr;
 - 2) LiOH;
 - 3) NH_4Cl ;
 - 4) AgCl;
 - 5) NaNO_3 .
3. Find a series which includes only those compounds that are shown in ionic reactions in the form of ions?
 - 1) CO, H_2O , Mg(OH)_2 , HCl;
 - 2) CH_4 , HBr, NaOH, AgCl;
 - 3) H_2SO_4 , KOH, $\text{Al}_2(\text{SO}_4)_3$, NaCl;
 - 4) HNO_3 , BaSO_4 , Ca(OH)_2 , KNO_3 ;
 - 5) HClO_4 , Al(OH)_3 , KCl, LiOH.
4. The reaction of barium-chloride and sulfuric acid produces the compound with low solubility:
 - 1) Hydrochloric acid;
 - 2) Barium-sulphate;
 - 3) Barium-chloride;
 - 4) 4) Barium-sulphite;
 - 5) Sulfuric acid.
5. Find the incorrect statement.
 - 1) Substitution is a chemical reaction of replacing atoms or groups of atoms in the molecules of reactants with other atoms or atomic groups;
 - 2) Reactions of analysis are reactions of combining two or more simple substances into a new, more complex substance;
 - 3) The reaction $\text{BaSO}_4 + \text{Na}_2\text{CO}_3 \rightarrow \text{BaCO}_3 + \text{Na}_2\text{SO}_4$ represents the exchange reaction;
 - 4) In ionic reactions, silver-chloride is a low soluble compound and is written in the form of molecule;
 - 5) 5) The reaction $8\text{Fe} + \text{S}_8 \rightarrow 8\text{FeS}$ represents the reaction of synthesis.

SOLUTIONS

- The process opposite to the dissolution process is called:
 - solvation;
 - hydration;
 - distillation;
 - filtration;
 - crystallization.
- The solubility of potassium-chloride is 37.2 g at 30 ° C. How many grams (g) of potassium-chloride are in 55.33 g of a saturated solution of this salt?
 - 137,32;
 - 18,13;
 - 15,00;
 - 20,58;
 - 92,53.
- What is the molar concentration of the solution of sulfuric acid with a percentage concentration of 96% if the density of that solution is 1,84 g/cm³. Ar(H) = 1; Ar(S) = 32; Ar(O) = 16.
 - 52,17;
 - 0,98;
 - 4;
 - 244,90;
 - 0,02.
- What is the molar concentration (mol/dm³) of the solution formed by mixing of 150 mL of 1 · 10⁻³ mol/dm³ sodium hydroxide solution and 350 mL of 0.05 mol/dm³ sodium hydroxide solution.
 - 1,5 · 10⁻⁴;
 - 1,75 · 10⁻²;
 - 1,75 · 10⁻³;
 - 3,53 · 10⁻²;
 - 3,53 · 10⁻⁴.
- Calculate the mass concentration (g/dm³) of the nitric acid water solution whose quantitative concentration is 0.15 mol/dm³. Ar(H) = 1; Ar(N) = 14; Ar(O) = 16.
 - 9,45;
 - 94,5;
 - 0,945;
 - 1,5;
 - 15.
- How many grams (g) of calcium-phosphate are needed to prepare 180 mL of the solution with a concentration of 0.08 mol/dm³? Ar(Ca) = 40; Ar(P) = 31; Ar(O) = 16.
 - 0,0144;
 - 1,44;
 - 0,08;

- 4) 4,464;
5) 8.
7. Calculate the molarity of the aqueous sodium-chloride solution containing 0.004 moles of dissolved substance in 20 mL of the solution. $A_r(\text{Na}) = 23$; $A_r(\text{Cl}) = 35,5$.
- 1) 4;
2) 0,2;
3) 0,4;
4) 2;
5) 0,04.
8. The percentage concentration of the solution formed by dissolving 5.6 g of calcium-oxide in 40.65 mL of water is: $A_r(\text{Ca}) = 40$; $A_r(\text{H}) = 1$; $A_r(\text{O}) = 16$
- 1) 13,78% CaO;
2) 18,20% Ca(OH)₂;
3) 12,11% CaO;
4) 16% Ca(OH)₂;
5) 7,4% Ca(OH)₂.
9. Calculate the molar concentration (mol/kg) of the hydrochloric acid solution at the concentration of 11.70 mol/dm³ if the density of the solution is 1.18 g/mL. $A_r(\text{H}) = 1$; $A_r(\text{Cl}) = 35,5$.
- 1) 15,54;
2) 36,2;
3) 0,365;
4) 0,15;
5) 1,55.
10. The ratio of the amount of dissolved substance and the volume of the solution is:
- 1) molal concentration;
2) percentage concentration;
3) molar concentration;
4) mass concentration;
5) molar (mole) fraction.

COLLOIDAL SOLUTIONS

1. The particle size of the dispersed phase in colloid dispersed systems is in the range from:
- 1) Less than 1 nm;
2) From 1 to 10 nm;
3) From 1 to 100 nm;
4) Larger than 100 nm;
5) 2 nm.

2. Coagulation of colloidal solutions is:
 - 1) diluting the solution;
 - 2) dissolution process;
 - 3) decanting process;
 - 4) the process of precipitation of colloidal solutions;
 - 5) adsorption process

3. Which of the following solutions are not the real solutions?
 - 1) Sugar in water;
 - 2) Solution of sodium-chloride in water;
 - 3) Milk;
 - 4) Diluted solution of hydrochloric acid;
 - 5) Aqueous solution of potassium nitrate.

4. By adding a larger amount of water, the gel can pass into:
 - 1) the real solution;
 - 2) hydrophobic colloidal solution;
 - 3) crystal;
 - 4) salt;
 - 5) there are no changes on that occasion.

5. What is the name of the process that occurs when a large amount of water is added to coagulated silver-chloride?
 - 1) Faraday-Tyndall effect;
 - 2) Coagulation;
 - 3) Sublimation;
 - 4) Extraction;
 - 5) Peptization.

COLLIGATIVE PROPERTIES OF THE SOLUTION

1. Colligative properties of the solution largely depend on:
 - 1) solvent polarity;
 - 2) molecular weights of the dissolved substance;
 - 3) solution mass;
 - 4) molecular weights of the solvent;
 - 5) the number of particles of the dissolved substance.

2. The aqueous solution of which of the listed compounds (the same concentrations) will show the lowest freezing temperature?
 - 1) Sodium-chloride;
 - 2) Urea;
 - 3) Aluminum-sulfate;
 - 4) Potassium-sulfate;
 - 5) Lithium-nitrate.

3. At what temperature does the solution obtained by dissolving 0.06 g of urea in 200 g of water freeze? The cryoscopic constant (molal depression constant) for water is $K_k = 1,86$. $Ar(C) = 12$; $Ar(N) = 14$; $Ar(H) = 1$; $Ar(O) = 16$.
- 1) $-9,3^{\circ}C$;
 - 2) $9,3^{\circ}C$;
 - 3) $0,093^{\circ}C$;
 - 4) $0,0093^{\circ}C$;
 - 5) $-0,0093^{\circ}C$.
4. How many grams (g) of urea should be dissolved in 250 mL of solution for the osmotic pressure of 0.15 atm at $25^{\circ}C$? $Ar(C) = 12$; $Ar(O) = 16$; $Ar(H) = 1$. (1 atm = 101 325 Pa)
- 1) $6,13 \cdot 10^{-3}$;
 - 2) $1,38 \cdot 10^{-3}$;
 - 3) 82,81;
 - 4) 0,00153;
 - 5) $9,2 \cdot 10^{-2}$.
5. At what temperature does the solution containing 1,32 g of calcium-nitrite in 250 g of water boil? The ebullioscopic constant (molal elevation constant) is $K_e = 0,52$. $Ar(Ca) = 40$; $Ar(N) = 14$; $Ar(O) = 16$.
- 1) 0,0624;
 - 2) 99,9376;
 - 3) 100,0624;
 - 4) 0,04;
 - 5) -0,0624.

ACIDS AND BASES. DISSOCIATION RATES. DISSOCIATION CONSTANT

1. Find the false statement.
- 1) According to the protolytic theory, acids are proton-releasing substances;
 - 2) For hydrochloric acid, the conjugate base is the chloride anion;
 - 3) For the ammonium ion, the conjugate base is the hydrogen ion H^+ ;
 - 4) According to the protolytic theory, it can be concluded that the bases are nucleophilic substances;
 - 5) According to the protolytic theory, the term acid or base does not mean the appropriate class of inorganic compounds, but the properties of molecules in a given environment.
2. Ion NO_3^- represents the conjugate base for:
- 1) HNO_2 ;
 - 2) NO ;
 - 3) NH_3 ;
 - 4) NH_2OH ;
 - 5) HNO_3 .

3. In the above-mentioned reactions, there will react as a base::



- 1) In the first reaction NH_4^+ , and in the second CH_3COOH ;
- 2) In the first reaction NH_4^+ , and in the second H_2O ;
- 3) In the first reaction H_2O , and in the second CH_3COOH ;
- 4) In both H_2O ;
- 5) In the first H_2O , while in the other among the reactants there is no molecule that acts as a base.

4. Calculate the constant of the conjugate acid if $\text{pK}_b(\text{NH}_3) = 4,8$.

- 1) $1,58 \cdot 10^{-4}$;
- 2) $1,58 \cdot 10^{-5}$;
- 3) $1,58 \cdot 10^5$;
- 4) $6,31 \cdot 10^{-10}$;
- 5) $6,31 \cdot 10^{10}$.

5. Calculate the degree of dissociation if it is known that in the system of a total of 500 molecules only 5 molecules have been dissociated (express in percent (%)).

- 1) 0,01;
- 2) 1;
- 3) 5;
- 4) 50;
- 5) 49,5.

6. Find the conjugate bases for the listed molecules and ions: HCN , NH_4^+ , HSO_4^- , H_2CO_3 .

- 1) CN^- , NH_4^+ , SO_4^{2-} , HCO_3^- ;
- 2) CN^- , NH_3 , SO_4^{2-} , HCO_3^- ;
- 3) CN^- , NH_3 , H_2SO_4 , HCO_3^- ;
- 4) HCN , NH_3 , SO_4^{2-} , HCO_3^- ;
- 5) CN^- , NH_3 , SO_4^{2-} , H_2CO_3 .

pH and pOH VALUE

1. Calculate the pH value of the solution if the concentration of OH^- ions is 10^{-8} mol/dm^3 .

- 1) 8;
- 2) 18;
- 3) 2;
- 4) 6;
- 5) 10.

2. What are the concentrations of H_3O^+ and OH^- ions if the pOH value of the solution is 9.
- 1) $[\text{H}_3\text{O}^+] = 9 \text{ mol/dm}^3$ и $[\text{OH}^-] = 5 \text{ mol/dm}^3$;
 - 2) $[\text{H}_3\text{O}^+] = 5 \text{ mol/dm}^3$ и $[\text{OH}^-] = 9 \text{ mol/dm}^3$;
 - 3) $[\text{H}_3\text{O}^+] = 10^{-5} \text{ mol/dm}^3$ и $[\text{OH}^-] = 10^{-9} \text{ mol/dm}^3$;
 - 4) $[\text{H}_3\text{O}^+] = 10^{-9} \text{ mol/dm}^3$ и $[\text{OH}^-] = 10^{-5} \text{ mol/dm}^3$;
 - 5) $[\text{H}_3\text{O}^+] = [\text{OH}^-] = 10^{-9} \text{ mol/dm}^3$.
3. How many milliliters (mL) of 0.05 mol/dm^3 sodium-hydroxide solution are needed to neutralize 500 mL of perchloric acid solution with pH value 2?
- 1) 10^{-2} ;
 - 2) $5 \cdot 10^{-3}$;
 - 3) $5 \cdot 10^3$;
 - 4) $5 \cdot 10^{-2}$;
 - 5) 10^2 .
4. Which solution is the most acidic one?
- 1) pH = 2;
 - 2) $[\text{H}^+] = 10^{-4} \text{ mol/dm}^3$;
 - 3) pH = 0;
 - 4) pOH = 13;
 - 5) $[\text{OH}^-] = 10^{-4} \text{ mol/dm}^3$.
5. What is the concentration of hydrocyanic acid (mol/dm^3) if the pH value of the solution is 5.05, and acid dissociation constant $4 \cdot 10^{-10}$.
- 1) $8,9 \cdot 10^{-6}$;
 - 2) $1,12 \cdot 10^{-9}$;
 - 3) 0,2;
 - 4) $4 \cdot 10^{-10}$;
 - 5) 2,5.
6. What is the pOH value of the solution containing 1.48 g of calcium-hydroxide in 400 mL of the solution. $\text{Ar}(\text{Ca}) = 40$; $\text{Ar}(\text{O}) = 16$; $\text{Ar}(\text{H}) = 1$.
- 1) 13;
 - 2) 1,30;
 - 3) 12,70;
 - 4) 1;
 - 5) 1,70.
7. Calculate the pH value of the solution containing $1,5 \cdot 10^{20}$ OH^- ions in 250 mL of the solution.
- 1) 3,61;
 - 2) 3;
 - 3) 5;
 - 4) 11;
 - 5) 10^{-3} .

BUFFERS

- Which mixture represents a buffer?
 - HNO_3 and NaNO_2 ;
 - KOH and NH_4Cl ;
 - CH_3COOH and NaCl ;
 - HNO_2 and KNO_2 ;
 - NH_3 and CaSO_4 .
- If ammonia (NH_3) molecules are found in the mixture with one of the above-mentioned compounds, then the resulting mixture will have buffering properties.
 - NaOH ;
 - NH_3 ;
 - NH_4Cl ;
 - $\text{Ca}(\text{OH})_2$;
 - CO .
- Which buffer is not biologically significant?
 - Bicarbonate;
 - Hemoglobin;
 - Phosphate;
 - Ammonia;
 - Protein.
- If a small amount of sodium-hydroxide is added to the aqueous solution consisting of ammonia and ammonium-chloride, then one of the listed component of the buffer system will react with the added OH^- ions:
 - base;
 - ammonia;
 - ammonium-hloride;
 - sodium-hydroxide;
 - components from the solution do not react.
- How many milligrams (mg) of sodium-acetate should be added into 200 mL of the solution of acetic acid with a concentration of 0.02 mol/L so that the concentration of H^+ ions of such solution is $9 \cdot 10^{-5}$ mol/L? The acid dissociation constant is $1,8 \cdot 10^{-5}$. $\text{Ar}(\text{C}) = 12$; $\text{Ar}(\text{H}) = 1$; $\text{Ar}(\text{O}) = 16$; $\text{Ar}(\text{Na}) = 23$.
 - 328;
 - 656;
 - 0,432;
 - 6,56;
 - 65,6.

6. What is the pH of the solution formed when 107 mg of ammonium-chloride is added to 100 mL of 0.05 mol/L ammonia solution. $K_b = 1,8 \cdot 10^{-5}$; Ar(H) = 1; Ar(N) = 14; Ar(O) = 16.
- 1) 4,35;
 - 2) 7;
 - 3) 9,65;
 - 4) 4,75;
 - 5) 10.
7. If we have 50 mL of ammonium-hydroxide solution with the concentration of 0.2 mol/L, how many milliliters (mL) of 0.1 mol/L hydrochloric acid need to be added to make a buffer solution?
- 1) 100 mL;
 - 2) 50 mL;
 - 3) 101 mL;
 - 4) 110 mL;
 - 5) 190 mL.
8. What is the concentration of H^+ ions in the solution in which the concentrations of ammonia and ammonium-chloride are equal and are 0,15 mol/dm³. The dissociation constant of ammonia is $1,8 \cdot 10^{-5}$.
- 1) $1,8 \cdot 10^5$ mol/dm³;
 - 2) $5,56 \cdot 10^{10}$ mol/dm³;
 - 3) $1,8 \cdot 10^{-5}$ mol/dm³;
 - 4) 0,15 mol/dm³;
 - 5) $5,56 \cdot 10^{-10}$ mol/dm³.
9. Which compound in the mixture with sodium-formate is the buffer system?
- 1) Sulfuric acid;
 - 2) Sodium-hydroxide;
 - 3) Methane acid;
 - 4) Perchloric acid;
 - 5) Potassium-hydroxide.

SALT. SALT HYDROLYSIS

1. Which compound does not hydrolyze?
- 1) $CaCl_2$;
 - 2) NH_4Cl ;
 - 3) KNO_2 ;
 - 4) $Al(ClO_4)_3$;
 - 5) $KClO$.

2. Which compound hydrolyzes alkally (produces solutions that are basic)?
- 1) NaOH;
 - 2) CaSO₄;
 - 3) NaNO₂;
 - 4) NH₂OH;
 - 5) HCl.
3. The aqueous solution of one of the listed compounds has the pH value greater than 7.
- 1) KNO₂;
 - 2) MnSO₄;
 - 3) H₂SO₃;
 - 4) BeSO₄;
 - 5) HClO₄.
4. In the reaction of sodium-hydroxide and one of the listed compounds, a new compound is formed - which does not undergo the hydrolysis reaction.
- 1) Nitric acid;
 - 2) Acetic acid;
 - 3) Sulfuric acid;
 - 4) Perchloric acid;
 - 5) Chloric acid.
5. The color of litmus paper is blue in the aqueous solution of one of the listed compounds.
- 1) FeCl₃;
 - 2) KCN;
 - 3) NaNO₃;
 - 4) NaCl;
 - 5) HClO₂.
6. How many milligrams (mg) of the basic (alkali) salt are formed in the reaction of 0.148 g of calcium-hydroxide with the appropriate amount of hydrochloric acid? Ar(Ca) = 40; Ar(O) = 16; Ar(H) = 1; Ar(Cl) = 35,5.
- 1) 185;
 - 2) 2;
 - 3) 0,002;
 - 4) 18,5;
 - 5) 0,185.
7. Find the neutral salt listed below that hydrolyzes acidically.
- 1) NaCl;
 - 2) KNO₂;
 - 3) KHCO₃;
 - 4) Fe(ClO₄)₂;
 - 5) FeOHSO₄.

8. If a chemical equation $\text{NH}_4^+ + \text{H}_2\text{O} \rightleftharpoons \text{NH}_3 + \text{H}_3\text{O}^+$ is read from the right to the left, then it represents a process that is the opposite of the hydrolysis process, and it is called:

- 1) distillation;
- 2) sublimation;
- 3) extraction;
- 4) peptization;
- 5) neutralization.

ELECTROLYSIS.

1. The electrolysis of molten zinc-iodide at the cathode separates:

- 1) Zn;
- 2) H_2 ;
- 3) H_2O ;
- 4) I_2 ;
- 5) O_2 .

2. The electrolysis of molten iron(III)-chloride at the anode separates:

- 1) Fe;
- 2) H_2 ;
- 3) Cl_2 ;
- 4) O_2 ;
- 5) H_2O .

3. During the electrolysis of molten sodium-chloride, the following process will occur at the cathode:

- 1) reduction of sodium ions;
- 2) oxidation of chlorine ions;
- 3) reduction of chlorine ions;
- 4) oxidation of oxygen;
- 5) oxidation of sodium ions.

4. Which mass (g) of molten sodium-hydroxide undergoes the electrolysis if 0.69 g of sodium is isolated at the cathode during that process? $\text{Ar}(\text{Na}) = 23$; $\text{Ar}(\text{O}) = 16$; $\text{Ar}(\text{H}) = 1$.

- 1) 0,69;
- 2) 69;
- 3) 40;
- 4) 1,2;
- 5) 12.

5. Find the equation that is not written correctly.

- 1) $\text{Fe} + \text{CuSO}_4 \rightarrow \text{FeSO}_4 + \text{Cu}$;
- 2) $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$;

- 3) $\text{Fe} + \text{CaSO}_4 \rightarrow \text{FeSO}_4 + \text{Ca}$;
- 4) $2\text{Na} + 2 \text{H}_3\text{O}^+ \rightarrow 2\text{Na}^+ + \text{H}_2 + 2\text{H}_2\text{O}$;
- 5) $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$.

6. Which metal can reduce H^+ -ion from the acid, ie. can release a molecule of hydrogen from the acid?

- 1) Cu;
- 2) Zn;
- 3) Ag;
- 4) Au;
- 5) Hg.

PERIODIC SYSTEM OF ELEMENTS

1. In which compound, the oxidation state of hydrogen is -1?

- 1) HBr;
- 2) NaOH;
- 3) LiH;
- 4) H_2O_2 ;
- 5) NH_3 .

2. An oxygen atom from a water molecule is hybridized:

- 1) sp;
- 2) d^2sp^3 ;
- 3) sp^3d^2 ;
- 4) sp^3 ;
- 5) sp.

3. In the reaction of sodium with 200.36 g of water, 224 mL of hydrogen was released. Calculate the molality of the produced sodium-hydroxide solution. (Measurements were performed under normal conditions). $\text{Ar}(\text{Na}) = 23$; $\text{Ar}(\text{H}) = 1$; $\text{Ar}(\text{O}) = 16$.

- 1) 0,01;
- 2) 0,02;
- 3) 0,1;
- 4) 1;
- 5) 0,2.

4. Find the false statement:

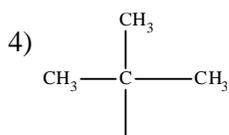
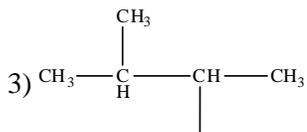
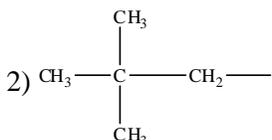
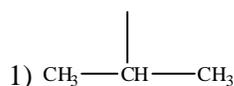
- 1) The general electronic configuration of the last energy level of alkali metal atoms is ns^1 ;
- 2) The first ionization energy of lithium is greater than the first ionization energy of rubidium;
- 3) Alkali metals are among the lightest metals;
- 4) For alkali metals, it is very difficult to release their electron building a positive M^+ ion;
- 5) In chemical reactions, cesium is more reactive than sodium.

5. Which one of the listed compounds is superoxide?
- 1) Na_2O_2 ;
 - 2) Li_2O ;
 - 3) Na_2O ;
 - 4) CO_2 ;
 - 5) KO_2 .
6. Calculate the percentage of sodium in sodium bicarbonate. $\text{Ar}(\text{Na}) = 23$; $\text{Ar}(\text{H}) = 1$; $\text{Ar}(\text{C}) = 12$; $\text{Ar}(\text{O}) = 16$.
- 1) 23;
 - 2) 46;
 - 3) 27,38;
 - 4) 76,22;
 - 5) 80.
7. Perchloric acid anhydride is:
- 1) Cl_2O ;
 - 2) Cl_2O_7 ;
 - 3) HCl ;
 - 4) ClO_2 ;
 - 5) NaCl .
8. The number of electrons, protons and neutrons in the ${}^4_2\text{He}$ atom is:
- 1) $e^- = 2$; $p^+ = 2$; $n^0 = 2$;
 - 2) $e^- = 2$; $p^+ = 2$; $n^0 = 4$;
 - 3) $e^- = 4$; $p^+ = 2$; $n^0 = 2$;
 - 4) $e^- = 2$; $p^+ = 4$; $n^0 = 2$;
 - 5) $e^- = 4$; $p^+ = 4$; $n^0 = 2$.

ALKANES

1. Which compound contains a quaternary carbon atom?
- 1) 2,4-dimethylpentane;
 - 2) n-pentane;
 - 3) neopentan;
 - 4) isobutane;
 - 5) n-heptane.
2. Which molecule has the highest boiling point?
- 1) Propane;
 - 2) Isobutane;
 - 3) n-Hexane;
 - 4) Isopentane;
 - 5) Neopentan.

3. Find the neopentyl group.



4. In which compound, the rotation and formation of conformational isomers are possible?

- 1) n-pentane;
- 2) isoprene;
- 3) o-xylene;
- 4) eten;
- 5) 1,3-cyclopentadiene.

5. How many milliliters (mL) of carbon(IV)-oxide are released during combustion of 112 mL of ethane (normal conditions)?

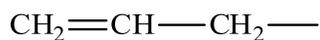
- 1) 112;
- 2) 224;
- 3) 448;
- 4) 672;
- 5) 0,224.

6. How many tertiary carbon atoms does a 5-ethyl-2,3-dimethylheptane molecule contain?

- 1) 7;
- 2) 5;
- 3) 4;
- 4) 0;
- 5) 3.

ALKENE

1. Find the correct name of the alkyl group shown in the figure.



- 1) propyl group;
- 2) isopropyl group;
- 3) vinyl group;
- 4) allyl group;
- 5) pentyl group.

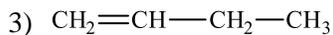
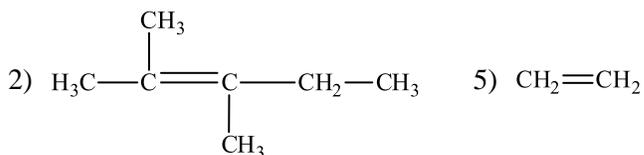
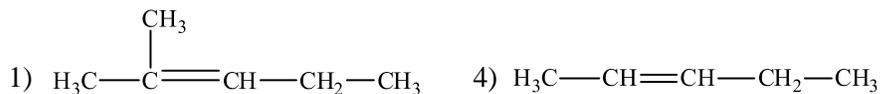
2. In the reaction of 2-butene with potassium-permanganate at room temperature, the main product is:

- 1) 2-butanol;
- 2) butane;
- 3) 3-butanol;
- 4) 2,3-butanediol;
- 5) 2,3-butylene oxide.

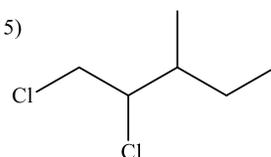
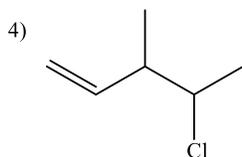
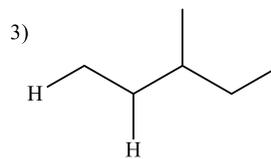
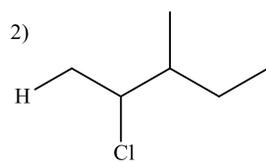
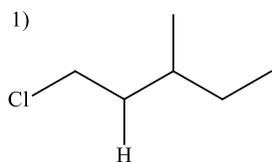
3. In which of the following compounds, the geometric cis/trans isomerism occurs?

- 1) 2-methyl-2-butene;
- 2) 1-chloro-2-methyl-butane;
- 3) 1,2-butadiene;
- 4) isobutane;
- 5) 2-pentene.

4. Find the most stable alkene.



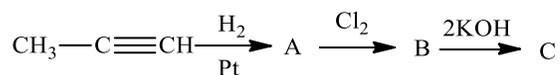
5. Find the correct structure of the compound formed by the reaction of 3-methyl-1-pentene and hydrochloric acid without a catalyst.



6. Which compound is formed by the reaction of bromine and 2-butene at room temperature?
- 1) butyl-bromide;
 - 2) 1,2-dibromo-butane;
 - 3) *sec*-butyl-bromide;
 - 4) *tert*-butyl-bromide;
 - 5) 2,3-dibromobutane.
7. Which molecule does not contain a sp^2 -hybridized carbon atom?
- 1) Isobutene;
 - 2) 2-methyl-2-butene;
 - 3) Vinyl chloride;
 - 4) Benzene;
 - 5) Cyclohexane.

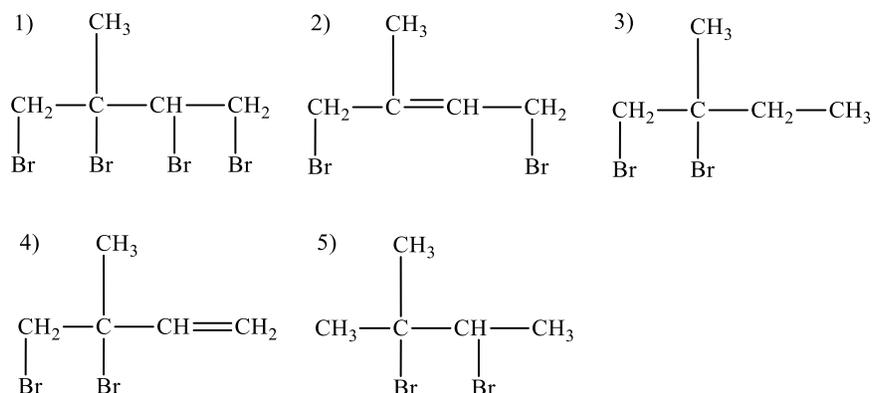
ALKINES AND DIENES

1. Which compound has an acidic character?
- 1) 1-butene;
 - 2) 2-butyne;
 - 3) 2-methylbutane;
 - 4) 4-methyl-2-pentene;
 - 5) 1-butyne
2. Find the cumulated diene.
- 1) 1,3-pentadiene;
 - 2) isoprene;
 - 3) 1,4-pentadiene;
 - 4) 1,2-pentadiene;
 - 5) 1,3-cyclohexadiene.
3. Find the unknown compounds so that the stated chemical equation is written correctly.

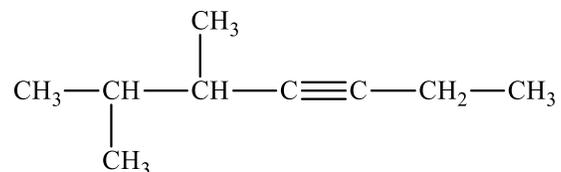


- 1) A = propane; B = 1,2-dichloropropane; C = 1-propyne;
- 2) A = propane; B = 1,1-dichloropropane; C = 1-propyne;
- 3) A = propene; B = 1,2-dichloropropane; C = 1-propyne;
- 4) A = propane; B = 1,2-dichloropropane; C = 1-propene;
- 5) A = propene; B = 1,2-dichloropropane; C = 1-propene.

4. Find the structure of the compound that is formed when isoprene reacts with bromine in the molar ratio of 1: 2.



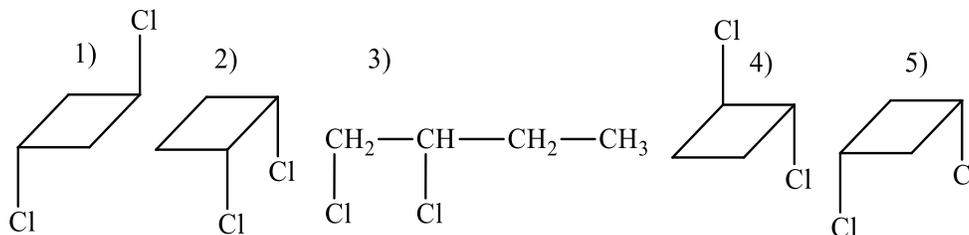
5. Find the correct name of the shown compound.



- 1) 2,3-dimethyl-4-heptin;
 2) 5,6-dimethyl-3-heptene;
 3) 2,3-dimethyl-4-heptene;
 4) 5,6-dimethyl-3-heptin;
 5) neoheptin.
6. How many grams (g) of the reaction product are formed by the reaction of 3.4 g of isoprene and 0.1 mol of bromine? $\text{Ar}(\text{Br}) = 80$; $\text{Ar}(\text{C}) = 12$; $\text{Ar}(\text{H}) = 1$.
- 1) 11,2;
 2) 38,8;
 3) 22,8;
 4) 112;
 5) 19,4.

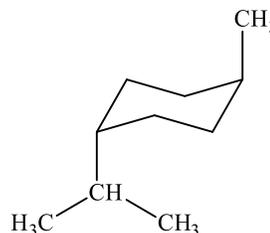
CYCLOALKANES

1. Find the structure of *cis*-1,2-dichlorocyclobutane.



2. Find the correct name for the displayed structure.

- 1) *cis*-1-methyl-4-isopropylcyclohexane;
- 2) 1-methyl-4-isopropylcyclohexane;
- 3) *trans*-1-methyl-2-isopropylcyclohexane;
- 4) 1-methyl-4-isopropylhexane;
- 5) *trans*-1-methyl-4-isopropylcyclohexane.



3. How many geometric isomers of 1,2-dimethylcyclobutane are there?

- 1) 12;
- 2) 3;
- 3) 2;
- 4) 24;
- 5) 8.

4. Find the compound formed in the reaction of cyclopentene and bromine.

- 1) 1,5-dibromopentane;
- 2) 1,1-dibromocyclopentane;
- 3) 1,2-dibromocyclopentane;
- 4) cyclopentyl-bromide;
- 5) 1,3-cyclopentadiene.

5. What is the product in the reaction of cyclohexane with hydrogen in the presence of nickel at 200 ° C?

- 1) No reaction occurs;
- 2) n-hexane;
- 3) 1-hexene;
- 4) 2-hexene;
- 5) 1-cyclohexene.

6. What is the angular deformation of the tetrahedral angle during the construction of cyclopropane?

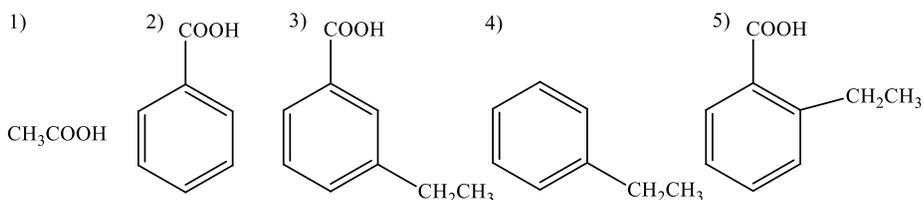
- 1) $109^{\circ}28'$;
- 2) $49^{\circ}28'$;
- 3) $19^{\circ}28'$;
- 4) 60° ;
- 5) 90° .

AROMATIC HYDROCARBONS

1. Find the false statement.

- 1) Benzene does not react with potassium-permanganate;
- 2) The bond length between two C-atoms in benzene is between a single and a double bond;
- 3) Arenes do not dissolve in water;
- 4) Arenes are mainly toxic compounds;
- 5) Benzene and benzene derivatives are subject to free radical substitution reactions.

2. Find the structure of the compound corresponding to the name *o*-ethylbenzoic acid.



3. Find the electrophilic reagent.

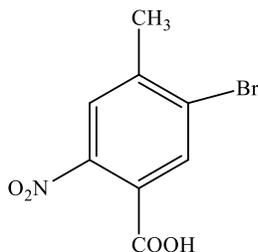
- 1) H_2O ;
- 2) OH^- ;
- 3) Br^- ;
- 4) NO_2^+ ;
- 5) CN^- .

4. Oxidation of isopropylbenzene with a strong oxidizing agent at high temperature gives one of the following compounds:

- 1) phthalic acid;
- 2) cyclohexene;
- 3) cyclohexanone;
- 4) acetic acid;
- 5) benzoic acid.

5. Which group is in the *ortho*-position relative to the methyl-group in the context of the present molecule?

- 1) -COOH;
- 2) -Br;
- 3) -NO;
- 4) -NO₂;
- 5) -CH₃.

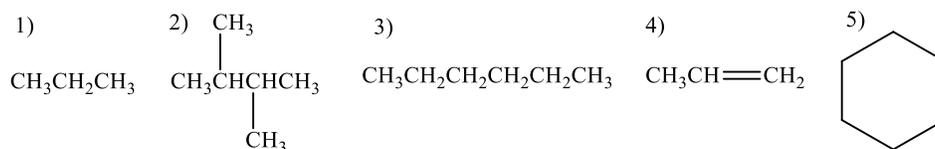


6. Find the electrophile that participates in the benzene nitration reaction.

- 1) HSO₄⁻;
- 2) NO₂⁺;
- 3) SO₃;
- 4) H₂O;
- 5) Br⁺.

ALKYL HALOGENIDS

1. Which compound is formed in the reaction of 2-chloropropane with metallic sodium?



2. In which compound, it is not possible to substitute the present halogen?

- 1) allyl-chloride;
- 2) cyclohexyl-chloride;
- 3) benzyl-chloride;
- 4) chlorobenzene;
- 5) ethyl-chloride.

3. Calculate the percentage of bromine in *o*-dibromobenzene. Ar(C) = 12; Ar(H) = 1; Ar(Br) = 80.

- 1) 1,6;
- 2) 32,20;
- 3) 67,80;
- 4) 30;
- 5) 50.

4. Find the compound formed in the addition reaction between vinyl-chloride and chlorine.
- 1) ethyl-chloride;
 - 2) 1,2-dichloroethene;
 - 3) 1,1,2-trichloroethane;
 - 4) ethin;
 - 5) 1,1,2,2-tetrachloroethane.
5. Which compound should be treated with phosphorus(III)-chloride to obtain isobutyl-chloride?
- 1) 1-butanol;
 - 2) *sec*-butanol;
 - 3) *tert*-butanol;
 - 4) 2-butanone;
 - 5) 2-methyl-1-propanol.
6. Which compound is formed in the reaction of propyl-chloride and water?
- 1) Propene;
 - 2) Propanol;
 - 3) Propyne;
 - 4) 1,2-propanediol;
 - 5) Glycerol.

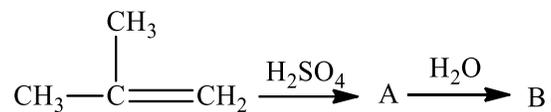
ALCOHOLS

1. How many different alcohols of molecular formula $C_4H_{10}O$ are there?
- 1) 4;
 - 2) 10;
 - 3) 5;
 - 4) 14;
 - 5) 1.
2. Which compound is formed as the final product in the reaction of methyl-magnesium-bromide with propanal, and some mineral acid?
- 1) 2-butanol;
 - 2) Methanol;
 - 3) Propanol;
 - 4) Propanoic acid;
 - 5) Butanone.

3. Which pair of compounds can be used to obtain 3-methyl-2-butanol?

- 1) Ethyl-magnesium-chloride and propanone;
- 2) Methyl-magnesium-bromide and propanal;
- 3) Isobutyl-magnesium-iodide and formaldehyde;
- 4) Isopropyl-magnesium-chloride and ethanal;
- 5) Isopropyl-magnesium-chloride and propanal.

4. Find the unknown compounds so that the following chemical equation is correctly written:



- 1) A = *tert*-butyl-hydrogensulfate; B = isobutanol;
- 2) A = *tert*-butyl-hydrogensulfate; B = *tert*-butanol;
- 3) A = *tert*-butyl-sulfate; B = *tert*-butanol;
- 4) A = isobutyl-hydrogensulfate; B = isobutanol;
- 5) A = *sec*-butyl-hydrogensulfate; B = *sec*-butanol.

5. Which compound is not ether?

- 1) *o*-cresol;
- 2) 1,4-dioxane;
- 3) Tetrahydrofuran;
- 4) Methoxy-benzene;
- 5) Vinyl-ethyl-ether.

6. Which alcohol cannot be obtained by the reduction of aldehydes and ketones?

- 1) *sec*-butanol;
- 2) 2-methyl-1-butanol;
- 3) 2-methyl-2-butanol;
- 4) Neopentanol;
- 5) Isopropanol.

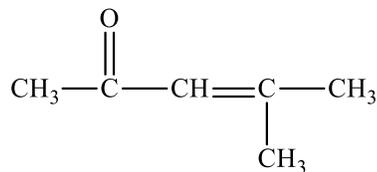
7. Which compound is formed in the reaction of 2-methyl-1-propanol with potassium-dichromate?

- 1) Isobutene;
- 2) Butanone;
- 3) Propanal;
- 4) 2-methyl-propanal;
- 5) Acetone.

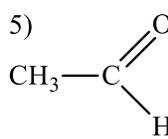
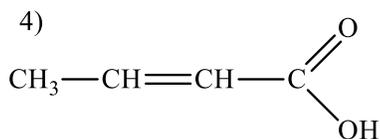
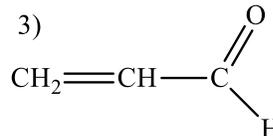
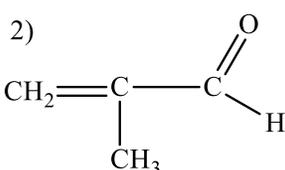
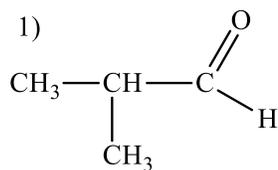
ALDEHYDES AND KETONES

1. Find the correct name of the compound shown in the figure.

- 1) 2-methyl-2-penten-3-one;
- 2) 4-methyl-3-penten-2-one;
- 3) methyl isobutyl ketone;
- 4) 2-butenal;
- 5) acrolein.



2. Find the structure of the compound corresponding to the name 2-methyl-2-propenal.



3. Which compound is formed in the reaction of ethanol and ethanol in the molar ratio of 1: 1 in an acidic medium?

- 1) Ethyl methyl ether;
- 2) Diethyl ketone;
- 3) 1-ethoxy-1-ethanol;
- 4) 1-butanol;
- 5) 1,1-butanediol.

4. Which compound can be formed when o-hydroxy-benzaldehyde is oxidized only at the aldehyde group?

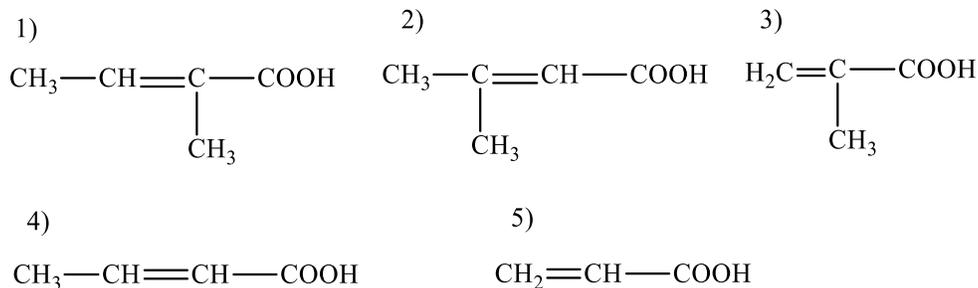
- 1) Benzoic acid;
- 2) Salicylic acid;
- 3) Phthalic acid;
- 4) Quinone;
- 5) Cyclohexanone.

5. Which compound is formed by the reaction of butanal with hydrogen in the presence of nickel as a catalyst?

- 1) Buten;
- 2) Bhutan;
- 3) Butanoic acid;
- 4) 1-butanol;
- 5) Butanone.

CARBOXYLIC ACIDS

1. Find the structure of the compound that corresponds to the name 2-methyl-2-butenoic acid.



2. Which compound is obtained by heating calcium-acetate at high temperatures?

- 1) Methane;
- 2) Ethane;
- 3) Propanal;
- 4) Ethanoic acid;
- 5) Acetone.

3. Determine the molecular formula of a carboxylic acid containing 48.6% carbon, 8.1% hydrogen and 43.2% oxygen. Ar(C) = 12; Ar(O) = 16; Ar(H) = 1.

- 1) $\text{C}_2\text{H}_4\text{O}_2$;
- 2) $\text{C}_4\text{H}_6\text{O}_2$;
- 3) $\text{C}_3\text{H}_6\text{O}_2$;
- 4) $\text{C}_3\text{H}_4\text{O}_2$;
- 5) $\text{C}_6\text{H}_{12}\text{O}_2$.

4. Why is a chloroacetic acid stronger acid than an acetic acid?

- 1) Because the hydrocarbon chain is longer in a hydrochloric acid;
- 2) Because the chlorine atom has a negative inductive effect;
- 3) Because the chlorine atom has a low ionization energy;
- 4) Because the chlorine atom has the property of easily transferring its electrons to the neighboring atoms;
- 5) The chlorine atom has no effect on the strength of the observed acids.

5. Find the compound with the most acidic character.

- 1) Methane acid;
- 2) Ethanoic acid;
- 3) Trichloroacetic acid;
- 4) Monochloroacetic acid;
- 5) Propanoic acid.

6. Which compound can form a propanoic acid by oxidation?

- 1) Propane;
- 2) Propyl-benzene;
- 3) Butanal;
- 4) Butanol;
- 5) Propanol.

FUNCTIONAL DERIVATIVES OF CARBOXYLIC ACIDS

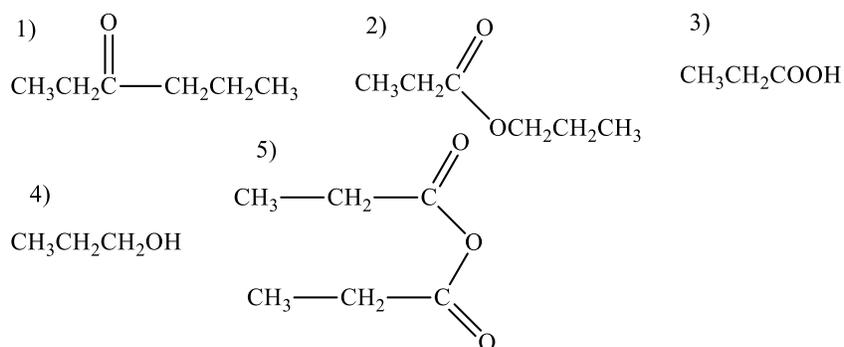
1. The reaction of the functional derivatives of carboxylic acids with ammonia is:

- 1) Decarboxylation;
- 2) Reduction;
- 3) Hydrolysis;
- 4) Alcoholism;
- 5) Amonolysis.

2. Which compound is formed in the reaction of a butanoic acid and phosphorus(III)-chloride?

- 1) Butyl chloride;
- 2) Butanoyl chloride;
- 3) Butanal;
- 4) 2-butanone;
- 5) 2-chloro-butanoic acid.

3. Which compound is formed in the reaction of sodium-propanoate and propanoyl-chloride?



3. Find the name of the compound shown in the figure.

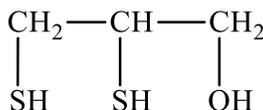


- 1) Diallyl-thioether;
 - 2) 1-propene-3-thiol;
 - 3) Diallyl-disulfide;
 - 4) Diallyl-sulfoxide;
 - 5) Diallyl-sulfone.
4. What type of the compound is formed in the reaction of hydrogen-peroxide and sulfides (thioethers) at room temperature?

- 1) Sulfons;
- 2) Sulfoxides;
- 3) Mercaptans;
- 4) Disulfides;
- 5) Sulfonic acids.

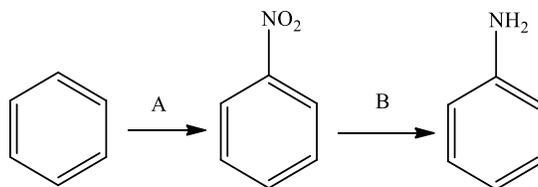
5. Find the correct name of the molecule shown in the figure.

- 1) propanol;
- 2) 1-mercapto-3-propanol;
- 3) 1,3-dimercapto-2-propanol;
- 4) 1,2-dimercaptopropane;
- 5) 2,3-dimercapto-1-propanol.



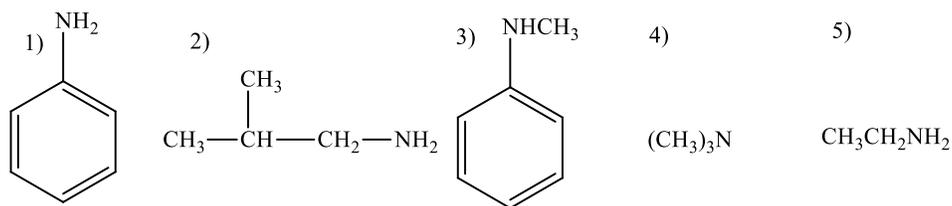
AMINES AND NITRO-COMPOUNDS

1. Find the unknown compounds so that shown chemical transformations are correct.

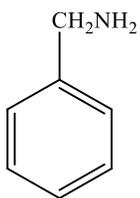


- 1) A = HNO₂/H₂SO₄; B = Fe/HCl;
- 2) A = HNO₃/H₂SO₄; B = Fe/HCl;
- 3) A = HNO₃/H₂SO₄; B = NH₃;
- 4) A = HNO₂; B = Fe/HCl;
- 5) A = HNO₃/H₂SO₄; B = NH₄OH.

2. Which compound is a secondary amine?

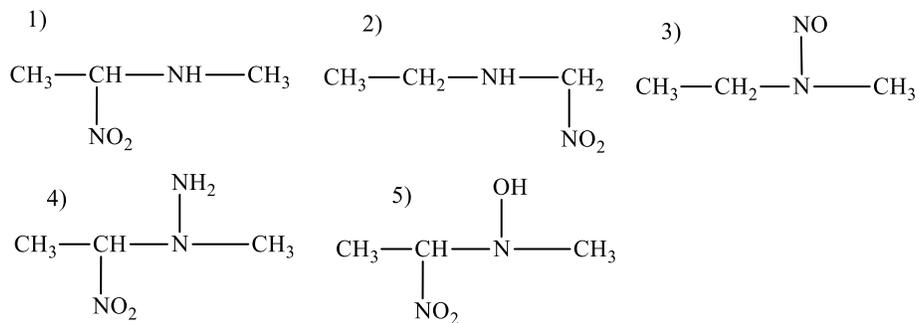


3. Find the name that corresponds to the compound shown in the figure.



- 1) Aniline;
- 2) Phenylmethanamine;
- 3) N-methyl-aniline;
- 4) Benzylamine;
- 5) Cyclohexylamine.

4. Which compound is formed in the reaction of ethyl methyl-amine with a nitric acid?



5. In which case does the quaternary ammonium ion occur?

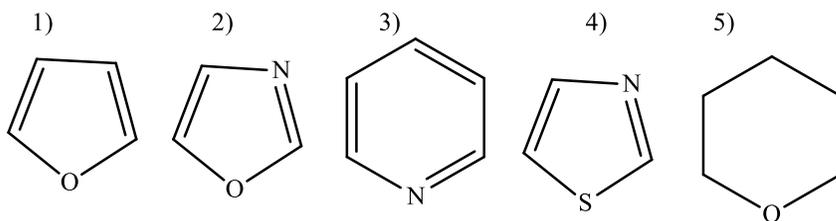
- 1) Trimethyl-amine;
- 2) N-methyl-aniline;
- 3) Benzyl-amine;
- 4) Acetylcholine;
- 5) Sulfanilamide

6. Find the primary aromatic amine.
- 1) Benzyl-amine;
 - 2) N, N-dimethyl-aniline;
 - 3) Trimethyl-amine;
 - 4) Cyclohexyl-amine;
 - 5) Aniline.

HETEROCYCLIC COMPOUNDS

1. Which compound is part of the porphyrin ring?
- 1) Pyridine;
 - 2) Quinoline;
 - 3) Imidazole;
 - 4) Pyrimidine;
 - 5) Pyrrole.
2. Which metal ion is part of vitamin B12?
- 1) Fe^{2+} ;
 - 2) Mg^{2+} ;
 - 3) Fe^{3+} ;
 - 4) Co^{2+} ;
 - 5) Na^+ .
3. Which compound is formed by decarboxylation of histidine?
- 1) 1,3-imidazole;
 - 2) Ethyl-amine;
 - 3) Pyrrole;
 - 4) Pyrrolidine;
 - 5) Histamine.
4. Cytosine, thymine and uracil are derivatives of one heterocyclic compound:
- 1) 1,3-thiazole;
 - 2) purine;
 - 3) 1,3-diazine;
 - 4) imidazole;
 - 5) pyridine.
5. Which of the following bases is only part of the RNA molecules?
- 1) Adenine;
 - 2) Cytosine;
 - 3) Guanine;
 - 4) Uracil;
 - 5) Thyme.

6. Find the structure of 1,3-oxazole.



CARBOHYDRATES

1. Which monosaccharide molecule is part of the ribonucleic acid?

- 1) Ribose;
- 2) Glucose;
- 3) 2-deoxy-ribose;
- 4) Chalcosis;
- 5) Fructose.

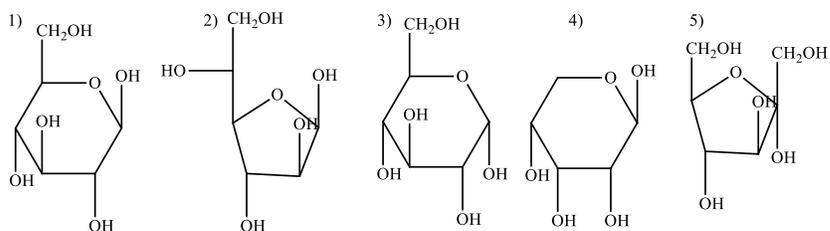
2. Which sugar component is part of the DNA molecules?

- 1) Ribose;
- 2) Glucose;
- 3) Mannose;
- 4) Fructose;
- 5) 2-deoxy-D-ribose.

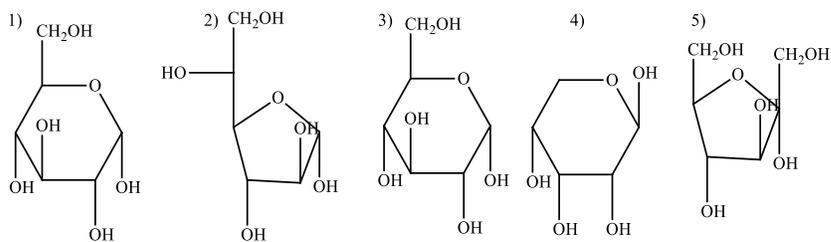
3. Find a molecule that represents 4-epimer-D-glucose.

- 1) D-mannose;
- 2) D-fructose;
- 3) L-glucose;
- 4) D-galactose;
- 5) L-mannose.

4. Find the structure of β -D-glucopyranose.



5. Find the structure of α -D-fructofuranose.



6. Which molecule of disaccharides, in addition to glucose molecules, also contains molecules of fructose?

- 1) Amylopectin;
- 2) Amylose;
- 3) Lactose;
- 4) Maltose;
- 5) Sucrose.

LIPIDS

1. Find the essential fatty acid.

- 1) Palmitic;
- 2) Arachidonic;
- 3) Palmitoleic;
- 4) Stearin;
- 5) Oleic.

2. Which lipids fall into the category of unsaponifiable lipids?

- 1) Neutral fats;
- 2) Phosphoglycerides;
- 3) Sphingolipids;
- 4) Waxes;
- 5) Steroids.

3. Which compound needs to be exposed to the sunlight to form Vitamin D3?

- 1) Ergosterol;
- 2) Vitamin D2;
- 3) 7-dehydrocholesterol;
- 4) Lanosterol;
- 5) Cholesterol.

4. Rickets (Rachitis) occurs in children due to the lack of _____.

- 1) vitamin C;
- 2) vitamin A;

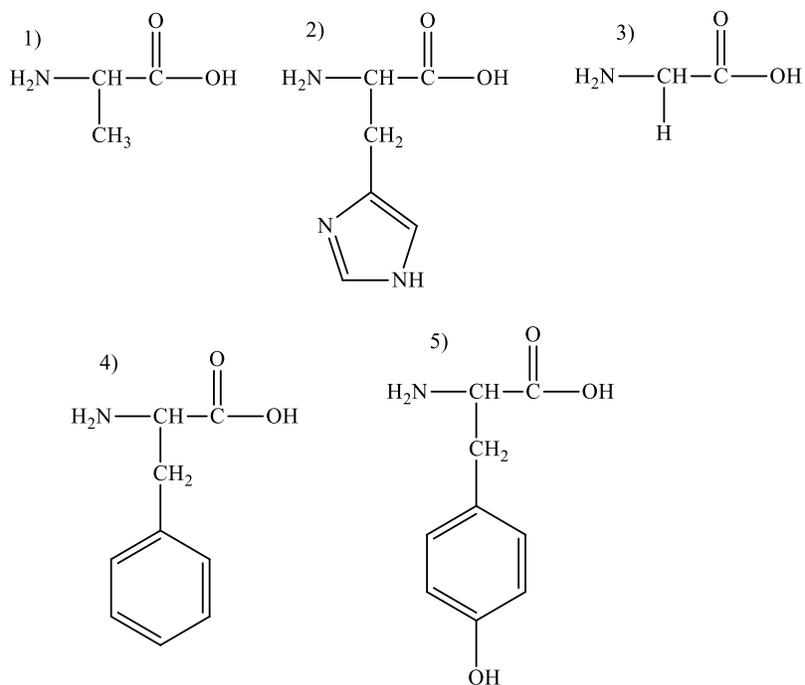
- 3) vitamin E;
- 4) vitamin D;
- 5) vitamin K.

5. How many moles of hydrogen are needed for complete hydrogenization of 2.8 g of linoleic acid?
 $Ar(C) = 12$; $Ar(H) = 1$; $Ar(O) = 16$.

- 1) 0,01;
- 2) 0,02;
- 3) 2;
- 4) 1;
- 5) 0,03.

AMINO ACIDS AND PROTEINS

1. Find an amino acid that does not contain a chiral (asymmetric) carbon atom.



2. Find an amino acid that contains the thioether group in the side chain.

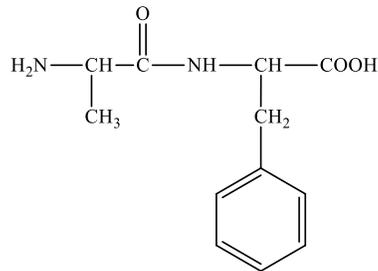
- 1) Methyllysine;
- 2) Lysine;
- 3) Isoleucine;
- 4) Methionine;
- 5) Cysteine.

3. Which amino acid contains the carboxyl group in the side chain?

- 1) Gln;
- 2) Asn;
- 3) Asp;
- 4) Ser;
- 5) Met.

4. Find the correct name for the compound shown in the figure.

- 1) Alanylphenylalanine;
- 2) Alanine-phenylalanine;
- 3) Phenylalanine-alanine;
- 4) Alaninephenylalanyl;
- 5) Valyltyrosine.



5. When, in the case of amino acids, the carboxyl group is deprotonated and the amino group is protonated, then the amino acid is in the form of:

- 1) zwitter-ion;
- 2) anion;
- 3) cation;
- 4) free radical;
- 5) such a form of amino acid is not possible.

6. Which amino acid does not fall into the category of essential for the human body?

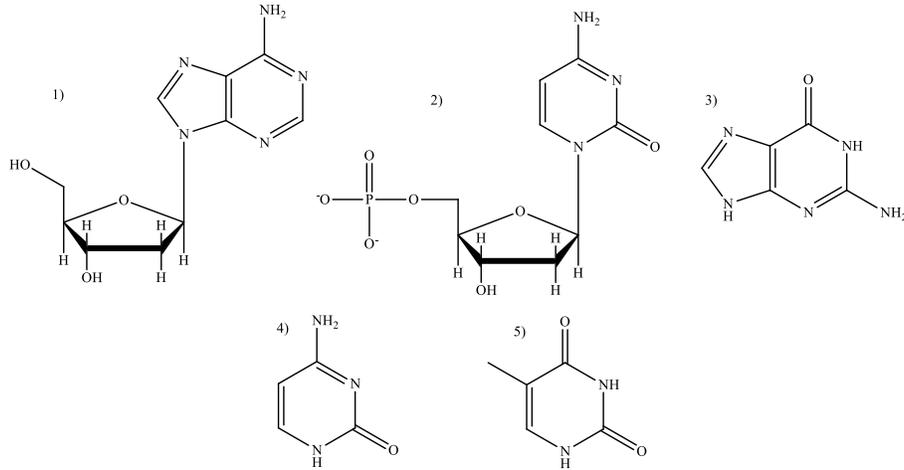
- 1) Valine;
- 2) Leucine;
- 3) Alanine;
- 4) Histidine;
- 5) Phenylalanine.

7. Which molecule contains the iron ion?

- 1) Chlorophyll;
- 2) Cystine;
- 3) Hemoglobin;
- 4) Tyrosine oxidase;
- 5) Aniline.

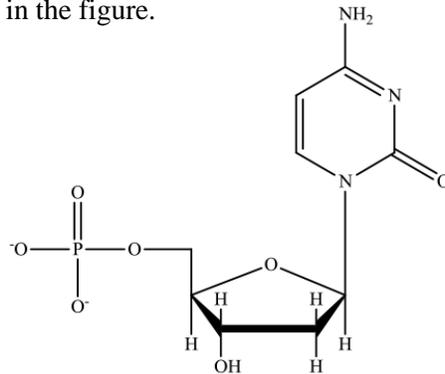
NUCLEIC ACIDS

1. Find the structure of cytosine.



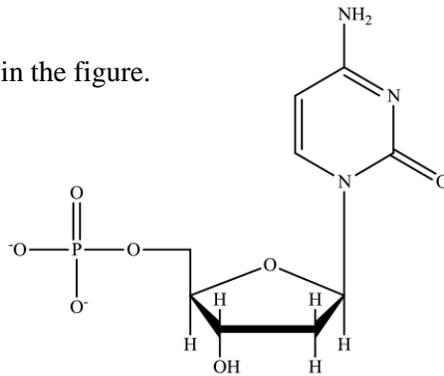
2. Find the correct name for the compound shown in the figure.

- 1) Deoxycytidine;
- 2) Deoxycytosine;
- 3) Cytidine monophosphate;
- 4) Deoxycytidine monophosphate;
- 5) Cytidine.



3. Find the correct name for the compound shown in the figure.

- 1) Deoxycytidine;
- 2) Deoxycytosine;
- 3) Cytidine monophosphate;
- 4) Deoxycytidine monophosphate;
- 5) Cytidine.



4. Which base is complementary to the purine base adenine in the DNA molecule?
- 1) Guanine;
 - 2) Cytosine;
 - 3) Thyme;
 - 4) Uracil;
 - 5) Guanosine.
5. Which nitrogen base is incorporated against guanine during the DNA replication?
- 1) Cytosine;
 - 2) Thyme;
 - 3) Adenine;
 - 4) Uracil;
 - 5) Purine.
6. Find the molecule of nucleotide.
- 1) Pyrimidine;
 - 2) Adenyl acid;
 - 3) Deoxycytidine;
 - 4) Guanosine;
 - 5) Uridine.
7. Find the molecule of nucleoside.
- 1) Deoxyadenosine monophosphate;
 - 2) Adenine;
 - 3) Cytidine monophosphate;
 - 4) Guanine;
 - 5) Uridine.
8. What is the chemical structure of adenosine monophosphate (AMP)?
- 1) Pyrimidine base;
 - 2) Nucleotide;
 - 3) Nucleoside;
 - 4) Carboxylic acid;
 - 5) Diene.