

**List of sample test questions for the entrance exam for the  
second level degree of full-time studies in**

**Chemical Technology**

**CHEMICAL TECHNOLOGIES IN ENERGY SECTOR**

**or**

**SUSTAINABLE FUELS ECONOMY**

**on**

**Faculty of Energy and Fuels & Faculty of Materials Science and Ceramics**

Abstract

---

This document presents a list of sample test questions for the entrance exam for the second level degree of full-time studies in Chemical Technology - CHEMICAL TECHNOLOGIES IN ENERGY SECTOR or SUSTAINABLE FUELS ECONOMY:

- the exam takes the form of a test exam and lasts 60 minutes,
- the test consists of 50 randomly selected questions,
- 2 points can be obtained for a correct answer, 0 points if the answer is incorrect; there are no half points or negative points,
- the maximum number of points on the test is equal to 100;
- if there is more than one correct answer, select one of the correct answers,
- the exam will be conducted on computer using the University E-Learning Platform (UPEL) it is necessary to have an active account,
- the test exam will be held in accordance with the recruitment calendar.

1. The rate of a chemical reaction does not depend on:
  - A) equilibrium constant
  - B) activation energy
  - C) a catalyst
  - D) temperature
2. In accordance with general principles of reactions occurring in the gas phase, the synthesis of ammonia:  $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3 + Q$  proceeds most effectively if:
  - A) temperature is lowered, and pressure raised
  - B) volume hydrogen-to-nitrogen ratio is 2:1
  - C) both pressure and temperature are lowered
  - D) temperature is raised and pressure lowered
3. The highest number of electrons of the same principal quantum number is:
  - A)  $2n^2$
  - B)  $n/2$
  - C)  $2n$
  - D)  $N$
4. The metallic character of elements in the same group increases together with the atomic number because:
  - A) atomic radii of elements grow, which facilitates ionization
  - B) the number of valence electrons increases
  - C) nuclear charge increases, which intensifies interaction between nucleus and electrons
  - D) greater atomic number indicates increased number of electrons and higher electronegativity
5. Solutions of hydrochloric acid of pH 2 and pH 4 have been prepared. Which of the following statements is true?  $\text{H}^+$  ion concentration in the solution:
  - A) of pH 2 is 100 times higher than in the solution of pH 4
  - B) of pH 2 is two times lower than in the solution of pH 4
  - C) of pH 2 is two times higher than in the solution of pH 4
  - D) of pH 2 is 100 times lower than in the solution of pH 4
6. The degree of electrolytic dissociation is determined by:
  - A) the ratio of the number of moles of the electrolyte which has undergone dissociation to the initial number of moles of the electrolyte
  - B) the ratio of ion concentration to dissociated molecule concentration
  - C) the algebraic sum of charge of ions into which the electrolyte molecule dissociates
  - D) the number of ions into which the electrolyte dissociates
7. Reactivity of metals belonging to a given main group increases together with increasing atomic number. This is mainly caused by:
  - A) an increase in the distance of valence electrons from the nucleus
  - B) an increase in the number of valence electrons
  - C) an increase in the total number of elementary particles in an atom
  - D) an increase in the number of electrons and neutrons in nuclei of atoms
8. In the process of electrolytic dissociation of ammonium sulfate are created:
  - A) ammonium cations and sulfate anions
  - B) ammonia and sulphur dioxide
  - C) ammonium anions and sulphuric acid residue
  - D) ammonia molecules and bisulfate ions

9. Molecule dipole moments of  $F_2$ ,  $Cl_2$ ,  $Br_2$ ,  $I_2$  are:
- A) in all cases equal to zero
  - B) in all cases different from zero and have similar values
  - C) different from zero, and their values increase from  $F_2$  to  $I_2$
  - D) different from zero, and their values decrease from  $F_2$  to  $I_2$
10. An element is a collection of atoms of:
- A) the same electric charge of the nucleus
  - B) the same mass number
  - C) the same number of neutrons
  - D) different atomic number
11. The main difference between a cell and an electrolytic cell consists in the fact that:
- A) in a cell, a reaction takes place spontaneously causing a flow of electrons in an external circuit, whereas in an electrolytic cell, the process is forced by an externally applied voltage which causes the movement of electrons in the opposite direction
  - B) in a cell, a reaction is forced by an externally applied voltage, whereas in an electrolytic cell, the process occurs spontaneously causing the flow of current
  - C) during electrolysis occur processes which generate potential difference
  - D) in an electrolytic cell occur only oxidation processes, whereas in a cell - only reduction processes
12. Analyzing the position of the main group elements in the periodic table, one can specify:
- A) the number of valence electrons
  - B) the number of isotopes of a given element
  - C) the number of compounds with oxygen
  - D) the numerical value of ionization energy
13. Removal of water hardness using soda involves removing from the solution the ions of:
- A) calcium
  - B) sulfate
  - C) chloride
  - D) sodium
14. Nitrogen at an oxidation state of -3 occurs in combination with:
- A) lithium and hydrogen
  - B) chlorine and bromine
  - C) oxygen and hydrogen
  - D) oxygen and chlorine
15. Metals of positive electrochemical potentials react with:
- A) concentrated acids, of strong oxidizing properties
  - B) anaerobic acids
  - C) diluted acids, of no oxidizing properties
  - D) concentrated acids, of no oxidizing properties
16. In which of the following compounds occur simultaneously covalent polarized, coordinate, and ion bonds:
- A)  $NH_4Cl$
  - B)  $NaOH$
  - C)  $H_2O$

- D)  $\text{MgCl}_2$
17. A molecule of carbon dioxide does not have a dipole moment because:
- A) it has symmetrical linear structure
  - B) there exists a covalent bond between carbon and oxygen atoms
  - C) it consists of atoms of different elements
  - D) carbon and oxygen are not different in terms of electronegativity
18. The bonds occurring between water molecules are the result of:
- A) association and interaction between the dipoles of water
  - B) interaction between strongly electronegative oxygen atoms
  - C) electrostatic interaction between hydrogen atoms belonging to different molecules
  - D) the existence of a shared electron pair between hydrogen and oxygen atoms
19. Chlorine is more reactive than bromine because of its:
- A) smaller atomic radius
  - B) lower electron affinity
  - C) lower ionization energy
  - D) lower number of neutrons in the nucleus
20. The aqueous solution of carbon dioxide and aqueous ammonia are poor conductors of electrical current. How will the conductivity change after mixing these solutions?
- A) it will increase
  - B) it will decrease
  - C) it will not change
  - D) it will significantly decrease
21. The dipole moment of a nitrogen molecule is equal to zero because atoms of nitrogen:
- A) have equal electronegativity
  - B) are not very reactive
  - C) undergo  $sp_2$  hybridization
  - D) form one sigma bond and two weak pi bonds
22. The solubility of hydrogen chloride in water under normal conditions is high because the compound:
- A) undergoes electrolytic dissociation in water
  - B) is a gas heavier than air
  - C) forms diatomic molecules
  - D) contains hydrogen in its composition
23. If the increase in pressure shifts the equilibrium to the right, it can be assumed that:
- A) the volume of reactants during a reaction decreases
  - B) the volume of reactants during a reaction increases
  - C) activation energy increases
  - D) the volume of reactants during a reaction is not changed
24. The essence of a metallic bonding consists in:
- A) electrostatic interaction between metal cations and electron gas formed from free electrons
  - B) formation of shared electron pairs by valence electrons of metal atoms
  - C) binding of metal atoms by the magnetic field generated by electron transfer
  - D) electrostatic interaction of ions of opposite signs

25. A multiple bond between atoms always consists of:
- one sigma bond and the remaining pi bonds
  - only pi bonds
  - only sigma bonds
  - one pi bond and the remaining sigma bonds
26. An ionic bond is formed between elements characterized by:
- the biggest electronegativity difference
  - the smallest electronegativity difference
  - identical electronegativity values
  - electronegativity differences do not affect the ability to form specific types of bonds
27. Diffusion is a process which consists in:
- spontaneous equalization of concentrations of solutions being a result of movement of substances from an area of higher concentration to the area of lower concentration
  - neutralization of the charge outside of the micelles caused by addition of a strong electrolyte
  - increasing solution concentration by movement of substances from precipitate to the solution caused by increased temperature
  - reducing solution concentration by spontaneous precipitation of a supersaturated solution
28. An aluminium magnesium alloy was dissolved in hydrochloric acid. Excess NaOH was added to the obtained solution. What is the form of aluminium after the reaction has been completed:
- in the solution, sodium aluminate  $\text{NaAlO}_2$
  - in the precipitate,  $\text{Al}[\text{OH}]_3$
  - an aluminium magnesium alloy is insoluble in aqueous solutions of HCl and NaOH
  - in the solution, aluminium chloride
29. In four test tubes were solutions containing the enumerated ions. After adding excess NaOH, the precipitate will remain in the tube containing ions of:
- $\text{Mg}^{2+}$
  - $\text{Cr}^{3+}$
  - $\text{Zn}^{2+}$
  - $\text{Al}^{3+}$
30. Ozone is:
- an allotrope of oxygen
  - an isomorphous form of oxygen
  - a homologue of oxygen
  - an isomer of oxygen
31. Hybridization of atomic orbitals is:
- a purely mathematical treatment leading to calculation of spatial distribution of electrons in molecules
  - a change in the shape of atomic orbitals due to electronegativity differences between atoms forming a bond
  - mixing wave functions of the atoms forming a bond
  - delocalisation of electrons over an entire molecule, as in e.g. a benzene molecule

32. The solid sodium hydroxide is hygroscopic, which means that:
- A) it absorbs water vapor from the air very well
  - B) it is highly soluble in water
  - C) it is highly soluble in water and the dissolution process is exoenergetic
  - D) it is highly soluble in water and the dissolution process is endoenergetic
33. After addition of a few drops of phenolphthalein to the aqueous solution of barium hydroxide [a.k.a. barium water], the solution will show raspberry colouration. After passing a certain gas through the vessel containing the above solution, its discolouration occurred. The in question gas could be:
- A)  $\text{CO}_2$
  - B)  $\text{HCl}$
  - C)  $\text{NH}_3$
  - D)  $\text{NO}$
34. After adding a small amount of solution containing compound X to a dilute solution of calcium chloride, a white precipitate was formed. The compound in question could be:
- A) ammonium oxalate
  - B) ammonium chloride
  - C) sodium chloride
  - D) ammonium nitrate[V]
35. In the container holding liquid water, steam, and ice in equilibrium, the system is:
- A) inhomogeneous
  - B) multiphase
  - C) homogeneous
  - D) single phase
36. In a molecule of sulphuric acid[VI] there is no:
- A) hydrogen bond
  - B) coordinate bond
  - C) polarized bond
  - D) single bond
37. To  $20 \text{ cm}^3$  of  $0.01\text{M Ca}[\text{OH}]_2$  solution were added  $20 \text{ cm}^3$  of  $\text{HCl}$  solution of the same concentration and a few drops of phenolphthalein. The solution after the experiment:
- A) showed a raspberry-red colouration
  - B) showed a yellow colouration
  - C) showed a blue colouration
  - D) was colourless
38. When a given element has high electron affinity, it means:
- A) a considerable amount of energy is emitted when an atom of the element in question gains an electron
  - B) a large amount of energy is required to obtain an anion of the element in question
  - C) the removal of one valence electron requires little energy
  - D) the element in question is not very reactive
39. In which of the following compounds are ionic bonds present:
- A)  $\text{CsBr}$
  - B)  $\text{AsCl}_2$
  - C)  $\text{Ni}_3$
  - D)  $\text{Cl}_2\text{O}$

40. The elements in the same group of the periodic table do not vary in terms of:
- A) configuration of valence electrons
  - B) the atomic radius
  - C) the number of protons in the nucleus
  - D) the number of neutrons in the nucleus
41. An atom which gained a certain number of electrons to create an 8-electron valence shell is:
- A) an anion
  - B) a cation
  - C) an electron
  - D) a nucleon
42. A magnesium ion,  $Mg^{2+}$  differs from an atom of magnesium in that:
- A) it has 8 electrons in the outer shell whereas an atom has 2
  - B) it has 2 electrons in the outer shell whereas an atom has 8
  - C) it has two electrons more than an atom
  - D) it has no valence electrons in the outer shell whereas an atom has 8
43. Sodium salts cause burner's flame to turn:
- A) yellow
  - B) yellow-green
  - C) carmine
  - D) brick red
44. An ammonium ion can be detected using:
- A) Nessler's reagent
  - B) acetone
  - C) water
  - D) it can not be detected
45. Neutralization reactions take place between:
- A) bases and acids
  - B) metals and acids
  - C) metal oxides and acids
  - D) metal and non-metal oxides
46. Which of the following substances should a zinc metal be treated with so that hydrogen is displaced:
- A) hydrochloric acid
  - B) a solution of calcium chloride
  - C) distilled water
  - D) sodium chloride
47. Which of the following compounds can be used to neutralize hydrochloric acid:
- A) potassium hydroxide
  - B) oxygen
  - C) nitric acid
  - D) hydrosulphuric water
48. The salt which is sparingly soluble is:
- A)  $AgCl$
  - B)  $NaCl$
  - C)  $Pb[NO_3]_2$
  - D)  $K_2SO_4$

49. Which group of compounds contains exclusively amphoteric compounds in aqueous environments:

- A)  $\text{Al}[\text{OH}]_3$ ,  $\text{Cr}[\text{OH}]_3$ ,  $\text{ZnO}$
- B)  $\text{Al}[\text{OH}]_3$ ,  $\text{Na}_2\text{O}$ ,  $\text{CuO}$ ,  $\text{ZnO}$
- C)  $\text{Zn}[\text{OH}]_2$ ,  $\text{CO}[\text{NH}_2]_2$ ,  $\text{CH}_3\text{COOH}$ ,  $\text{MnO}_2$
- D)  $\text{Cr}[\text{OH}]_3$ ,  $\text{SiO}_2$ ,  $\text{SO}_3$ ,  $\text{HOCH}_2\text{COOH}$

50. Which of the described phenomena are chemical, not physical changes:

- A) formation of red tarnish on an iron nail dipped in a solution of  $\text{CuSO}_4$
- B) white smoke formation in a container with hydrochloric acid into which ammonia vapors were introduced
- C) neon glow on a light advertisement
- D) formation of a layer of ice on freezer walls in a refrigerator

51. Which of the following compounds is the strongest acid:

- A)  $\text{HClO}_4$
- B)  $\text{HClO}_3$
- C)  $\text{HClO}_2$
- D)  $\text{HClO}$

52. From which oxide can  $\text{HClO}_4$  acid be obtained:

- A)  $\text{Cl}_2\text{O}_7$
- B)  $\text{Cl}_2\text{O}$
- C)  $\text{Cl}_2\text{O}_3$
- D)  $\text{Cl}_2\text{O}_5$

53. The most reactive non-metal is:

- A) fluorine
- B) carbon
- C) oxygen
- D) iodine

54. Acid-base titration consists in:

- A) an acid-base reaction
- B) oxidation and reduction reactions
- C) a reaction in which complex compounds are created
- D) a reaction in which a sparingly soluble precipitate is formed

55. In alkalimetry, the term *titrant* marks:

- A) a strong acid
- B) a strong base
- C) a base of any strength
- D) a weak acid

56. The titration point at which a marked component reacted quantitatively stoichiometrically with titrant added from a burette, is called:

- A) equivalence point
- B) endpoint
- C) stoichiometric point
- D) quantitative point

57. Industrial minerals are:

- A) barite, gypsum, strontium salts
- B) anhydrite, coal, precious metal ores
- C) radioactive elements, fluorite, rock salt
- D) pyrite, apatite, marble

58. Which coal types are thermal coals:
- A) 31
  - B) 33
  - C) 35
  - D) 37
59. Which mines extract lignite:
- A) Konin
  - B) Turów
  - C) Sieniawa
  - D) Halemba
60. The calorific value of natural gas:
- A) among other things, depends on ethane and propane content in its composition
  - B) is greater than its heat of combustion
  - C) is comparable to the calorific value of LPG and lower than the calorific value of coke oven gas
  - D) in the case of high-methane natural gas, does not exceed 20 MJ/m<sup>3</sup>
61. A typical composition of biogas obtained in fermentation process comprises:
- A) methane, nitrogen, ammonia, carbon dioxide
  - B) methane, carbon dioxide, ammonia, nitrogen, hydrogen sulfide
  - C) methane, carbon monoxide, carbon dioxide, hydrogen, hydrogen chloride
  - D) methane, argon, carbon dioxide, helium
62. According to the Renewable Energy Sources Act, biomass does not include:
- A) bioliquids used for energy purposes other than transportation
  - B) biodegradable waste from fishing
  - C) biodegradable part of sewage sludge
  - D) agricultural residues of biological origin which undergo biodegradation
63. The great industrial disaster which took the highest death toll was:
- A) Bhopal [India]
  - B) Chernobyl [USSR]
  - C) Vajont [Italy]
  - D) Texas City [USA]
64. Preventive and countering services for effects of major industrial accidents in Poland do not include:
- A) State Aviation Agency
  - B) The National Labour Inspectorate
  - C) The Office of Technical Inspection
  - D) State Fire Service
65. An *upper-tier establishment* is a facility:
- A) which exceeds the upper threshold of the hazardous substances inventory specified by the EU
  - B) which performs activities that are life- and health-threatening to the employees
  - C) which performs activities that are harmful to the environment
  - D) whose production volumes of hazardous substances exceed the standards established for it by a competent minister

66. A safety report must be prepared and submitted by:
- A) high-risk facility operators
  - B) upper-tier establishment and high-risk facility operators
  - C) operators of all heavy industry facilities
  - D) operators of all facilities
67. Gas cylinders for flammable gases are painted:
- A) blue
  - B) yellow
  - C) green
  - D) red
68. Repairs of gas pipelines can be performed by:
- A) a person holding suitable qualifications obtained in a state certification exam
  - B) any personnel member of a company
  - C) only a trained person
  - D) only specialized external companies
69. The Office of Technical Inspection deals with:
- A) admission and supervision of equipment operation posing a serious threat to human life and health
  - B) preparation of commissioning documentation for industrial installations
  - C) supervision of business operations
  - D) supervision of industrial production
70. Guidelines for safe machine and equipment design:
- A) are included in the Labour Code
  - B) are included in applicable national standards
  - C) are included in the guidelines of the Office of Technical Inspection
  - D) result from specificity of a place and their functioning
71. Can a workstation be equipped with a device without certified safety marking:
- A) yes, if it holds a certificate of conformity
  - B) yes
  - C) yes, but only after placing a warning board
  - D) no
72. Special-risk work posing a threat to human health and life should be performed by:
- A) minimum 2 persons
  - B) one person
  - C) minimum 3 persons
  - D) only brigades of specialized companies
73. 2-chlorobutane can be obtained from butane in the reaction of:
- A) radical substitution
  - B) electrophilic substitution
  - C) radical addition
  - D) electrophilic addition
74. If contaminants do not dissolve hot, while a formulation of interest does, it is required that:
- A) a clear solution is decanted hot
  - B) a mixture is passed through a deposit of a high surface area substance
  - C) a mixture is cooled and filtered cold
  - D) components of a mixture are separated in a separatory funnel

75. A separatory funnel is used for:  
A) separation of two immiscible liquids  
B) decantation  
C) crystallization  
D) separation of two miscible liquids
76. To burn 1 m<sup>3</sup> of methane, should be delivered approximately:  
A) 32.5 m<sup>3</sup> of air  
B) 16.5 m<sup>3</sup> of air  
C) 22 m<sup>3</sup> of air  
D) 37 m<sup>3</sup> of air
77. Heptane can be distinguished from 1-heptane by:  
A) reaction with a solution of potassium manganate[VII]  
B) leaving both substances in contact with air [oxidation]  
C) reaction with nitric[V] acid  
D) mixing both substances with alcohol
78. A mixture of fats decomposing at the boiling point can be separated by:  
A) steam distillation  
B) water extraction  
C) simple [atmospheric] distillation  
D) liquid chromatography
79. The weight ratio of carbon to hydrogen and oxygen in benzoic acid is:  
A) 84:6:32  
B) 84:7:2  
C) 7:6:2  
D) 72:6:16
80. In cold crystallization of organic substances, the solvent is chosen so that:  
A) contaminants are dissolved cold and a formulation hot  
B) both contaminants and a formulation are dissolved hot  
C) contaminants are dissolved hot and a formulation cold  
D) both contaminants and a formulation are dissolved cold
81. 1-butanol can be distinguished from 2-methyl-2-propanol by:  
A) oxidation together with Tollens' test  
B) sulfonation  
C) oxidation by potassium manganate[VII]  
D) nitration
82. Structural (functional) isomerism is an aspect of:  
A) constitutional isomerism  
B) stereoisomerism  
C) configurational (geometric) isomerism  
D) spatial isomerism
83. Acyl derivatives of carboxylic acids include:  
A) acid halides and anhydrides, acid esters and amides  
B) alcohols, esters, acid amides and halides  
C) esters, nitriles, acid amides and anhydrides  
D) ethers, amides, acid anhydrides and halides

84. The role of boiling chips in heating mixtures in a flask is:  
A) protection against overheating of a liquid and ejection from the flask  
B) protection against decomposition of organic substances  
C) ensuring uniform heat transfer  
D) forcing the appearance of gas bubbles in order to improve mixing
85. 2-pentene can be distinguished from 1-pentene by:  
A) ozonolysis  
B) oxidation with atmospheric oxygen  
C) reaction with the solution of bromine in tetrachloromethane  
D) the differences in miscibility with water
86. Oxidation products of 2-methylpropan-1-ol can be:  
A) 2-methylpropional or 2-methylpropanoic acid  
B) 2-methylpropan-2-ol or 2-methylpropanoic acid  
C) 2-methylpropanoyl or 2-methylpropanoic acid  
D) 2-methylpropional or butanoic acid
87. Propanal can be distinguished from the propanone by reaction with:  
A) ammonia  
B) hydrocyanic acid  
C) water  
D) chloric[I] acid
88.  $C_6H_{11}OH$  can be distinguished from  $C_6H_5OH$  by reaction with:  
A) benzo-diazine chloride in a solution of NaOH  
B) phenylhydrazine  
C) propanone  
D) methoxybenzene
89. Toluene in reaction with chlorine in the presence of  $FeCl_3$  yields predominantly:  
A) a mixture of 2-chlorotoluene and 4-chlorotoluene  
B) 2-chlorotoluene  
C) 3-chlorotoluene  
D) a mixture of 2-chlorotoluene and 3-chlorotoluene
90. Compounds  $C_nH_{2n+2}O$ ,  $C_nH_{2n+1}NO_2$  and  $C_nH_{2n+1}CHO$  belong to the following groups:  
A) alkanols or alkoxy alkanes, nitroalkanes, alkanals  
B) alkanols, amino alkanes, alkanons  
C) alkanols, nitroalkanes, alkanal-acids  
D) alkoxy alkanes, nitroso-alkanes, alkanals
91. Chemical analysis of a certain compound shows mass ratio C:H:O = 7:14:2. The compound in question can be:  
A) carboxylic alkanal-acid  
B) alkanodione  
C) alkanal  
D) alkanone
92. The molecular formula  $C_4H_{10}O$  includes constitutional isomers in the number of:  
A) 7  
B) 4  
C) 5  
D) 9

93. The homologues of benzene are:
- toluene
  - naphthalene
  - aniline
  - phenol
94. In order to separate a crystallized product from a solution, it is necessary to apply:
- percolation at lower pressure
  - simple distillation
  - extraction
  - chromatography
95. In order to distinguish different bond orders of alcohols, are used:
- Lucas test, esterification, reaction with sodium
  - a Grignard reagent, esterification, reaction with sodium
  - reaction with sodium hydroxide, etherification, oxidation
  - Lucas test, Tollens' test, reaction with sodium hydroxide
96. In order to separate aldehyde from alcohol-ketone solution, it is necessary to use:
- ammonia
  - a Grignard reagent
  - sodium bisulphate[III]
  - hydroxylamine
97. N-fenylacetamid is a product of acetylation of aniline proceeding according to the mechanism of:
- nucleophilic substitution
  - radical addition
  - electrophilic substitution
  - nucleophilic addition
98. Benzene can be visually distinguished from cyclohexene by reactions:
- of combustion, with a solution of potassium manganate[VII], with a solution of bromine in tetrachloromethane
  - of ozonolysis, with sodium hydroxide, with a solution of potassium manganate[VII]
  - with a Grignard reagent, with a solution of bromine in tetrachloromethane, with sulphuric[VI] acid
  - of combustion, with hydrazine, with a solution of bromine in tetrachloromethane
99. The following compounds A: 1-chloro-1-butene, B: 3-chloro-1-butene, C: 4-chloro-1-butene, D: 1-chlorobutane were ranked by increasing reactivity of the halide, which is shown by notation:
- $A < C = D < B$
  - $A < B < C = D$
  - $D < B < A < C$
  - $B < D < C < A$
100. The reaction between chloride ethanoil and aniline in the presence of a catalyst [iron trichloride] proceeds according to the mechanism of:
- electrophilic substitution
  - nucleophilic substitution
  - electrophilic addition
  - nucleophilic addition

101. The product of Claisen condensation between ethanal and butan-2-one is:
- A) 3-methyl-4-pentanol-2-one
  - B) 5-hexanol-3-one
  - C) 3-methyl-1-pentanal-3-ol
  - D) 5-hexanol-2-one
102. Butane can be visually distinguished from 1-butyne by reactions of:
- A) combustion, with sodium, with a solution of bromine in tetrachloromethane, with a solution of potassium manganate[VII]
  - B) ozonolysis, with hydrogen iodide, with sodium, with sulphuric[VI] acid
  - C) hydrogenation, with sodium hydroxide, with hydrogen bromide, with a solution of potassium manganate[VII]
  - D) combustion, with hydroxylamine, with sulphuric[VI] acid, with a solution of bromine in tetrachloromethane
103. Structural unit cells in metals are:
- A) regular and hexagonal
  - B) regular and rhombohedral
  - C) trigonal and hexagonal
  - D) trigonal and rhombohedral
104. Dislocations are crystal lattice defects:
- A) one-dimensional
  - B) zero-dimensional
  - C) two-dimensional
  - D) three-dimensional
105. Graphite melts:
- A) does not melt
  - B) at temperature 4100
  - C) at temperature 4500
  - D) at temperature 3800
106. The critical carbon content distinguishing between steel and cast iron is:
- A) 2.11%
  - B) 0.77%
  - C) 3.40%
  - D) 4.30%
107. Which of the following is not a light metal?:
- A) zinc
  - B) magnesium
  - C) beryllium
  - D) titanium
108. Devitrificate is:
- A) partly crystallised glass
  - B) stained glass
  - C) glass of high refractive index
  - D) tempered glass

109. Clay components do not include:
- A) limonite
  - B) illite
  - C) halloysite
  - D) kaolin
110. Which of the following is not a polymer decomposition reaction?
- A) destabilisation
  - B) depolymerization
  - C) degradation
  - D) destruction
111. Synthetic polymers are conglomerates of chemical bonds:
- A) covalent- secondary bonds
  - B) ionic- secondary bonds
  - C) metallic-covalent bonds
  - D) metallic- secondary bonds
112. Which of the following is not a structural form of liquid crystals:
- A) peritectic form
  - B) smectic form
  - C) nematic form
  - D) cholesteric form
113. Which of the following measurements are not taken when determining the thermal comfort parameters and PMV/PPD indicators:
- A) solar radiation level measurements taken with a pyrometer
  - B) radiant temperature measurements with a black ball
  - C) airflow velocity measurements taken with a thermal anemometer
  - D) relative humidity of air measurements with a hytherograph
114. Temperature sensors which require the electric power supply directly to the sensors are:
- A) electronic sensors [such as DS18S20, LM35]
  - B) thermocouples [K type]
  - C) thermistors [for example NPC]
  - D) resistance temperature sensors [for example PT100]
115. The thermal conductivity coefficient of insulating materials is not dependent on:
- A) dimensions of insulating material
  - B) the type of insulating material
  - C) moisture content of insulating material
  - D) density of insulating material
116. Thermistor whose resistivity decreases with temperature is referred to as:
- A) NTC resistor
  - B) PTC resistor
  - C) CTR resistor
  - D) PMV resistor
117. Contact-free temperature measurements consist in:
- A) measurements of IR radiation intensity
  - B) measurements of thermal properties of a test object upon heating it with laser radiation

- C) analysing the convective gas flow
- D) measurements of light intensity

118. Which of the following is a bad conductor of heat:

- A) styrofoam
- B) water
- C) copper
- D) bricks

119. Heat transfer, also referred to as heat exchange, is a natural phenomenon occurring when there is a difference in temperature. Which mode of heat flow is incorrect in terms of physical mechanisms?

- A) transmission
- B) radiation
- C) conduction
- D) convection

120. The reference point on the absolute temperature scale is:

- A) temperature at which the thermal movement of particles ceases
- B) temperature of water freezing
- C) liquid nitrogen temperature
- D) temperature of liquid oxygen

121. A hygrometer is device for measuring:

- A) relative humidity
- B) noise level
- C) light intensity
- D) temperature

122. Temperature measurements with a thermocouple consist in:

- A) measurements of electromotive force on the metal-metal interface
- B) measuring the differences of thermal expansion of the two metals
- C) measuring the change of electric resistance of the metal-metal interface
- D) measuring the intensity of current flow through the junction between the two metals

123. Bimetallic thermometer operation is based on the following measurements:

- A) measurements of strain caused by the difference between linear expansions of two metals
- B) extension of the optical path after the mirror is shifted
- C) extension of the thermo-bimetallic pile
- D) deformation as a result of material softening

124. A black body features:

- A) high capability of thermal radiation absorption
- B) low capability of thermal radiation absorption
- C) high capability of thermal radiation reflection
- D) high capability of thermal radiation transmission

125. Thermistor is a temperature-measuring device in which:

- A) resistivity changes with increasing temperature
- B) electromotive force increases with increasing temperature
- C) electromotive force decreases with increasing temperature
- D) capacity decreases with increasing temperature

126. Conventional (mercury- or alcohol-filled) thermometers utilise:
- the phenomenon of volume expansion with increasing temperature
  - change of the medium's colour with increasing temperature
  - concentration change with increasing temperature
  - the phenomenon of linear expansion with increasing temperature
127. Work generated by 1 mol of monoatomic ideal gas within the closed process cycle is 418 J. Heat transferred by gas during those processes is equal to:
- 418 J
  - zero
  - 418 J
  - cannot be specified
128. In order to perform volume-pressure work upon the surroundings while maintaining the constant internal energy, the system:
- takes up energy from the surroundings [ $Q > 0$ ]
  - gives up heat to the surroundings [ $Q < 0$ ]
  - does not exchange energy with the surroundings
  - raises temperature
129. The change of internal energy is equal to heat transferred in a closed system during the following process:
- an isochoric process
  - an adiabatic process
  - an isobaric process
  - an isentropic process
130. Given the following values of the heat of formation:  $\text{H}_2\text{O}[\text{g}]$ , (Htw., 298 K = -242 [kJ/mol],  $\text{CO}[\text{g}]$ , (Htw., 298 K = -11 [kJ/mol], the value of  $\Delta H_{298 \text{ K}}$  for the reaction  $\text{H}_2\text{O}[\text{g}] + \text{C}[\text{s}] = \text{H}_2[\text{g}] + \text{CO}[\text{g}]$  becomes:
- +131 [kJ/mol]
  - 353 [kJ/mol]
  - 131 [kJ/mol]
  - +353 [kJ/mol]
131. Any extensive function of state of a closed system in which a reaction of  $n$  components takes place will be the function:
- of three variables
  - of two variables
  - of  $n$  variables
  - of one variable
132. For any thermodynamic process:
- the change of internal energy of the system is path independent
  - heat absorbed by the system is path independent
  - work performed by the system is path independent
  - internal energy is constant
133. The bond energy C-H in methane is expressed as:
- $\frac{1}{4}$  [H for reaction  $\text{CH}_4[\text{g}] = \text{C}[\text{s}] + 2\text{H}_2[\text{g}]$ ]
  - $\frac{1}{4}$  [H for reaction  $\text{CH}_4[\text{g}] = \text{C}[\text{s}] + 4\text{H}[\text{g}]$ ]
  - [H for reaction  $\text{CH}_4[\text{g}] = \text{C}[\text{s}] + 2\text{H}_2[\text{g}]$ ]
  - [H for reaction  $\text{CH}_4[\text{g}] = \text{C}[\text{s}] + 4\text{H}[\text{g}]$ ]

134. The reaction co-ordinate expresses:
- the rate of reaction
  - heat of reaction
  - equilibrium state of reaction
  - irreversibility of reaction
135. When gas absorbs thermal energy of 200 J and expands by 500 cm<sup>3</sup> against constant pressure  $2 \times 10^5$  [N/m<sup>2</sup>], the change of internal energy equals:
- + 100 J
  - 300 J
  - 100 J
  - + 300 J
136. The overall energy of an isolated system in which a process proceeds at a finite rate:
- will always increase
  - will always decrease
  - remains constant
  - may increase or decrease
137. For most liquids, the molar entropy of vaporization at normal boiling temperature equals:
- 85 [JK<sup>-1</sup> mol<sup>-1</sup>]
  - 8.3 [JK<sup>-1</sup> mol<sup>-1</sup>]
  - 20 [JK<sup>-1</sup> mol<sup>-1</sup>]
  - 25 [JK<sup>-1</sup> mol<sup>-1</sup>]
138. For the reaction  $\text{CO}_{(g)} + \text{H}_2\text{O}_{(g)} = \text{H}_2_{(g)} + \text{CO}_2_{(g)}$
- $K_p = K_c$
  - $K_p$  is equal to one
  - $K_p > K_c$
  - $K_p < K_c$
139. For athermal solutions:
- $H^E = 0, G^E = 0, S^E > < 0$
  - $H^E = 0, G^E > < 0, S^E > < 0$
  - $H^E = 0, G^E > < 0, S^E = 0$
  - $H^E > = 0, G^E = 0, S^E > < 0$
140. The overall vapour pressure of an ideal solution is related to vapour composition by:
- a nonlinear dependence
  - a linear dependence
  - is not related
  - an exponential dependence
141. For positive azeotropes, phase diagrams of the equilibrium of the vapour-liquid systems reveal the presence of:
- maximum in the isothermal process
  - minimum in the isobaric process
  - maximum in the isobaric process
  - minimum in the isothermal process

142. For liquid solutions A and B, positive deviations from the Raoult's law are caused by molecular interactions:
- A)  $A-A > A-B$
  - B)  $A-A = B-B$
  - C)  $A-A < B-B$
  - D)  $A-A > B-B$
143. At temperature 400 K the vapour pressure of liquid A is  $4 \times 10^4$  [Nm<sup>-2</sup>] and of liquid B-  $6 \times 10^4$  [Nm<sup>-2</sup>]. Liquids A and B form an ideal solution. The molar fraction B in vapour remaining in equilibrium with the solution in which the molar fraction B is 0.6 will be equal to:
- A) 0.69
  - B) 0.31
  - C) 0.40
  - D) 0.50
144. Vapour pressure of liquid A in a presence of immiscible liquid B is:
- A) independent of the molar fraction A in the system
  - B) proportional to the molar fraction A in the system
  - C) logarithmic function of temperature
  - D) linear function of temperature
145. Elevation of boiling point is the result of addition of one of the following substances to the solvent:
- A) Non-volatile substance
  - B) surface-active substance
  - C) insoluble substance
  - D) volatile substance
146. The cryoscopic constant value is dependent on:
- A) solvent
  - B) solute
  - C) solvent and solute
  - D) neither solvent nor solute
147. The thermodynamic equilibrium involves:
- A) all listed factors
  - B) mechanical equilibrium [of forces and moments of force]
  - C) chemical equilibrium [absence of chemical reactions]
  - D) thermal equilibrium [no heat transfer]
148. The Zero law of thermodynamics enables the measurement of:
- A) temperature
  - B) pressure
  - C) internal energy
  - D) specific heat
149. Ideal gas:
- A) satisfies the fundamental gas laws
  - B) it is a water vapour or water
  - C) it is gas inside a closed container
  - D) has a constant internal energy

150. An adiabatic process:
- A) is a process involving no heat exchange
  - B) is a constant-enthalpy process
  - C) is a process involving no friction
  - D) is a process when the energy of the system remains constant
151. An open system interacts with its surroundings through:
- A) transport of mass, heat and work
  - B) work or heat
  - C) volume change
  - D) temperature change
152. The second law of thermodynamics:
- A) defines entropy
  - B) defines heat
  - C) defines enthalpy
  - D) defines efficiency
153. Specific heat of gas is dependent on:
- A) all listed factors
  - B) type of gas only
  - C) gas temperature
  - D) gas pressure
154. IR radiation is absorbed by:
- A) all molecules in which the dipole moment is changed as a result of vibration
  - B) SO<sub>2</sub>
  - C) all molecules
  - D) all diatomic molecules
155. Is the wave number a measure of energy?
- A) yes
  - B) no
  - C) it depends on the actual energy value
  - D) it depends on the electromagnetic wave frequency
156. In polarography, the characteristic quantity identifying ions is:
- A) half-wave potential
  - B) residual current
  - C) diffusion current
  - D) limiting current
157. Polarimetric analysis is one of:
- A) refractometry methods
  - B) electrochemical methods
  - C) thermal methods
  - D) diffractometry methods
158. Instrumental methods of pH measurement use the following:
- A) a glass electrode
  - B) a calomel electrode
  - C) a hydrogen electrode
  - D) a golden or lead electrode

159. Atomic emission spectroscopy [AES] is one of the methods:  
A) qualitative and quantitative methods  
B) quantitative only  
C) qualitative only  
D) neither qualitative nor quantitative determination is possible
160. Differential thermal analysis [DTA]:  
A) allows the investigation of exothermic and endothermic effects during the sample heating  
B) allows the examination of clays and illite  
C) does not allow the investigation of polymorphous processes  
D) analyses the mass changes in the function of temperature
161. Conductometry:  
A) is an electrochemical method  
B) is a non-selective method  
C) is a selective method  
D) is used to determine the pH of solutions
162. Resolutions of an optical microscope and of a transmission electron microscope (TEM) are:  
A) optical 1 $\mu$ m, TEM 0.22 nm  
B) optical 400 nm, TEM 1.5 nm  
C) optical 200 nm, TEM 2 nm  
D) optical 0.5  $\mu$ m, TEM 10 nm
163. Magnetic quantum number expresses:  
A) position of the orbital angular momentum in space  
B) the shell on which the electron is found  
C) the value of the orbital angular momentum of an electron  
D) spin
164. Atomic absorption spectroscopy [AAS] is used for:  
A) quantitative determination  
B) qualitative determination  
C) quantitative and qualitative determination  
D) neither qualitative nor quantitative determination
165. Conductometry method is used for:  
A) quantitative determination  
B) qualitative determination  
C) quantitative and qualitative determination  
D) neither qualitative nor quantitative determination
166. Conductometry consists in measurements of the following:  
A) conduction  
B) current voltage  
C) current intensity  
D) current intensity and voltage
167. The length of de Broglie's wave is expressed by the formula [where: m- mass, v- velocity, h- Planck constant]:  
A)  $\lambda = h/mv$   
B)  $\lambda = mv/h$   
C)  $\lambda = mh/v$   
D)  $\lambda = vh/m$

168. Interference occurs in the case of waves which:
- A) propagate in the same direction
  - B) have a time-constant phase-shift
  - C) have identical frequency
  - D) have identical amplitude
169. Turbidimetric analysis is an analytical method utilising:
- A) light dispersion
  - B) light absorption
  - C) light refraction
  - D) light diffraction
170. The thermodynamic equilibrium involves:
- A) all listed factors
  - B) mechanical equilibrium [of forces and moments of force]
  - C) chemical equilibrium [absence of chemical reactions]
  - D) thermal equilibrium [no heat transfer]
171. Avogadro's law specifies:
- A) the number of molecules in one mol of substance
  - B) the number of a molecule's degrees of freedom
  - C) gas volume under normal conditions
  - D) universal gas constant
172. An adiabatic process:
- A) is a process involving no heat exchange
  - B) is a constant-enthalpy process
  - C) is a process involving no friction
  - D) is a process when the energy of the system remains constant
173. An open system interacts with its surroundings through:
- A) transport of mass, heat and work
  - B) work or heat
  - C) volume change
  - D) temperature change
174. The second law of thermodynamics:
- A) defines entropy
  - B) defines heat
  - C) defines enthalpy
  - D) defines efficiency
175. Which of the following is a psychrometric mixture:
- A) atmospheric air
  - B) water and ice mixture
  - C) exhaust gas
  - D) water vapour and water
176. The Dalton's law for ideal gases determines:
- A) pressure of a mixture component
  - B) volume of a gas mixture
  - C) the proportion of a mixture component
  - D) density of a gas mixture

177. Van der Waals equation of state describes:
- A) properties of liquids and gases
  - B) the state of a semi-ideal gas
  - C) properties of gas only
  - D) properties of liquid only
178. Parameters on the saturation line H<sub>2</sub>O for x=0 include:
- A) h' - enthalpy of boiling water
  - B) v'' - specific density of saturated dry steam
  - C) r - heat of vaporization of water
  - D) T - water temperature
179. Thermodynamic cycle stands for:
- A) duty cycle of an engine or a heat pump
  - B) a number of subsequent processes
  - C) operation of a heat exchanger
  - D) water heating and cooling
180. The efficiency of the circulation of a thermal engine is determined by:
- A) engine work or power
  - B) amount of heat supplied
  - C) A / B ratio of the above-mentioned quantities
  - D) B / A ratio of the above-mentioned quantities
181. The efficiency of Rankine cycle can be increased through:
- A) increase of the fresh stream parameters (before the turbine)
  - B) pressure increase in the condenser
  - C) reduction of H<sub>2</sub>O pressure in the boiler
  - D) burning of larger amounts of fuel or a better quality fuel
182. A spark-ignition combustion cycle is referred to as:
- A) Otto cycle
  - B) Brayton cycle
  - C) Linde cycle
  - D) Ericson cycle
183. Heat pump is also referred to as:
- A) a refrigerator operated in the heating mode
  - B) a heat water pump in a heating installation
  - C) a condensate pump in a steam turbine
  - D) a pump for handling hot geothermal waters
184. Steady-state heat exchange in a combined process applies to:
- A) heat penetration through barriers
  - B) heat transfer on both sides of the barrier
  - C) heat conduction through barrier elements
  - D) accumulation and giving up heat by the barriers
185. Which of the following is a pass heat exchanger:
- A) freon evaporator in a compression refrigerator
  - B) an electric-heated water- storage boiler
  - C) a steam engine in a municipal thermal power plant
  - D) a building wall accumulating solar heat

186. The highest theoretical cycle efficiency applies to:
- the clockwise process in the Carnot cycle
  - engine cycle with heat regeneration
  - a gas turbine in a combined heat and power plant
  - a supercritical cycle in a steam power station
187. Gases A and B in a gas mixture have the same molar fraction and the ratio of their mole mass is  $M_A/M_B=2$ . What is the ratio of their gas constants  $R_A/R_B=?$
- $R_A/R_B=1/2$
  - $R_A/R_B=1$
  - $R_A/R_B=2$
  - $R_A/R_B=2/3$
188. Arrange the heat transfer coefficients in the increasing order: boiling -w; laminar forced convection[l]; turbulent convection [t], natural convection-[n], condensation [s]:
- natural convection/ laminar convection/ turbulent convection/ boiling/ condensation
  - condensation/ laminar convection/ turbulent convection/natural convection/boiling
  - boiling/condensation/turbulent convection/laminar convection/natural convection
  - turbulent convection/natural convection/laminar convection/condensation/boiling
189. Efficiency of the counter-clockwise process represents:
- efficiency of the heating or cooling process
  - thermal efficiency of the cycle
  - work or power output of the plant only
  - the values of evaporation and condensation temperature
190. Exergy expresses:
- the system's ability to perform the maximal work
  - the system's ability to overcome the losses
  - properties of a substance in equilibrium with its ambience
  - mechanical and thermal energy of a system or a substance
191. According to the Lambert-Beer law, intensity of light passing through a medium with the concentration c:
- decreases exponentially with concentration
  - increases linearly with concentration
  - increases exponentially with concentration
  - decreases linearly with concentration
192. Intensity of light dispersed by a colloidal solution is:
- inversely proportional to  $\lambda^4$
  - proportional to concentration of a colloidal solution c
  - proportional to the incident light wavelength  $\lambda$
  - inversely proportional to  $c^4$
193. The relationship between frequency of gas molecule collisions Z and thermodynamic temperature T is given as:
- $Z \sim T^{1/2}$
  - $Z \sim T$
  - $Z \sim \exp[-\text{const}/T]$
  - Z is not related to T

194. Three molecules of gas have the velocities: 100, 200, 300 [m/s]. The mean square molecular velocity equals:
- A) 216 [m/s]
  - B) 190 [m/s]
  - C) 200 [m/s]
  - D) 400 [m/s]
195. Volume occupied by 1 mole of helium under pressure  $10^5$  [N/m<sup>2</sup>] at temperature 1000 K is approximately equal to:
- A) 83 dm<sup>3</sup>
  - B) 22.4 dm<sup>3</sup>
  - C) 108 dm<sup>3</sup>
  - D) 770 dm<sup>3</sup>
196. The equation of state for an ideal gas at high temperature and under high pressure [taking into account the specific volume of molecules expressed with the factor  $b$ ] is given as:
- A)  $pV=RT+bp$
  - B)  $pv=bRT$
  - C)  $pV= RT +b$
  - D)  $pV= RT -b$
197. Liquid viscosity at increased temperatures:
- A) decreases exponentially
  - B) increases linearly
  - C) decreases linearly
  - D) increases exponentially
198. Van der Waals forces are:
- A) dipole-dipole interactions
  - B) inductive interactions
  - C) dispersive interactions
  - D) ion-ion interactions
199. Vapour pressure over a drop of liquid is:
- A) higher than over a flat surface
  - B) the same as the one over a flat surface
  - C) lower than the one over a flat surface
  - D) does not depend on the shape of a surface
200. Electrophoresis is:
- A) motion of colloidal particles under the influence of the electric field
  - B) liquid motion under the influence of the electric field
  - C) motion of dipoles in the electric field
  - D) flow of ions under the influence of the electric field
201. If adding a substance to water lowers its surface tension, then:
- A) adsorption of this substance is positive
  - B) adsorption of this substance is negative
  - C) it does not have anything in common with adsorption
  - D) adsorption of this substance occurs

202. In solutions of the same concentration the increase in the length of a hydrocarbon chain in the homologous series of organic acids brings about:

- A) lowering of the surface tension
- B) increase of the surface tension
- C) does not affect the surface tension
- D) the increase of acid solubility

203. A body is wettable by liquid if the wetting angle is:

- A)  $\theta < 90^\circ$
- B)  $\theta < 45^\circ$
- C)  $\theta = 90^\circ$
- D)  $90^\circ < \theta < 180^\circ$

204. Langmuir's adsorption isotherm is based on the assumption of:

- A) constant warmth of adsorption
- B) flat constant surface
- C) ideal gas behaviour
- D) activation energy of adsorption and desorption processes which is equal to zero

205. The BET adsorption isotherm makes it possible to calculate:

- A) the amount of adsorbate creating a monolayer
- B) the specific surface of the adsorbent
- C) adsorption warmth
- D) volume of the adsorbent's micropores

206. The potential of the glass electrode depends on the activity of :

- A)  $H^+$  ions
- B)  $Na^+$  ions
- C)  $Cl^-$  ions
- D)  $OH^-$  ions

207. Ionic strength of a water solution of barium chloride of a concentration of 0.1  $[mole \cdot kg^{-1}]$  is equal to :

- A) 0.3  $[mole \cdot kg^{-1}]$
- B) 0.1  $[mole \cdot kg^{-1}]$
- C) 0.15  $[mole \cdot kg^{-1}]$
- D) 0.2  $[mole \cdot kg^{-1}]$

208. Mole conductivity of a solution is a:

- A) quotient of electrolytic conductivity and solution concentration
- B) product of electrolytic conductivity and solution concentration
- C) sum of electrolytic conductivity and a solution concentration
- D) difference of electrolytic conductivity and a solution concentration

209. A radius of ionic atmosphere is:

- A) inversely proportional to the ionic strength
- B) proportional to the ionic strength
- C) does not depend on the ionic strength
- D) the exponent of the ionic strength

210. A transport number  $t_+ = 0$  in:
- metallic conductors
  - ionic conductors
  - semiconductors
  - complex conductors
211. Electromotive strength of a concentration cell depends on a:
- quotient of activity of potential-bearing ions
  - kinds of electrodes
  - difference of activity of potential-bearing ions
  - sum of activity of potential-bearing ions
212. Ion mobility can be expressed in units:
- $[m^2 \cdot s^{-1} \cdot V^{-1}]$
  - $[m \cdot s^{-1}]$
  - $[m \cdot s^{-1} \cdot V^{-1}]$
  - $[m \cdot s^{-1} \cdot V^{-2}]$
213. The SEM value makes it possible to directly determine:
- $\Delta G$ ,
  - $\Delta\mu$
  - Q
  - $\Delta H$  (for the reaction occurring in a cell)
214. The SEM of a cell is positive when:
- on the left electrode there is an oxidation reaction
  - on the left electrode there is a reduction reaction
  - on the right electrode there is an oxidation reaction
  - the normal potential of the left electrode is higher than that of the right one
215. The velocity of the ionic reaction in a solution is:
- an exponential function  $\sqrt{I}$
  - proportional to  $\sqrt{I}$
  - does not depend on the ionic strength
  - depends on a dissociation degree
216. The velocity constant of a second-order reaction can be expressed in :
- $[dm^3 \cdot mol^{-1} \cdot min^{-1}]$
  - $[cm^3 \cdot molecule^{-1} \cdot s^{-1}]$
  - $[mol \cdot m^{-3} \cdot s^{-1}]$
  - $[molecule \cdot cm^{-3} \cdot s^{-1}]$
217. The period of a half-transition of a second-order process ( $2A = \text{two products}$ ) is:
- inversely proportional to the initial concentration A
  - independent of the initial concentration A
  - directly proportional to the initial concentration A
  - logarithm of the initial concentration A
218. A catalyst is a substance which:
- accelerates a reaction
  - changes the course of a reaction
  - changes a constant of a reaction balance
  - reduces a reaction velocity

219. If  $\Delta H$  for a reaction is equal to  $+100 \text{ [kJ x mol}^{-1}\text{]}$ , the activation energy:
- A) must be equal or higher than  $100 \text{ [kJ x mol}^{-1}\text{]}$
  - B) must be equal or smaller than  $100 \text{ [kJ x mol}^{-1}\text{]}$
  - C) can be higher or smaller than  $100 \text{ [kJ x mol}^{-1}\text{]}$
  - D) is not connected with  $\Delta H$  of a reaction
220. An ester hydrolysis in the presence of a diluted HCl occurs according to the kinetics of the first-order reaction because:
- A) the concentration of hydrogen ions is generally constant during the reaction
  - B) acid works as a catalyst
  - C) a hydrolysis velocity does not depend on concentration of hydrogen ions
  - D) there is a big excess of water
221. The cause of an explosive course of the reaction is
- A) the occurrence of follow-up reactions
  - B) the presence of a catalyst
  - C) the occurrence of many parallel reactions
  - D) the temperature increase
222. A monomolecular reaction may occur according to the mechanisms of the second-order reactions:
- A) at low pressures
  - B) at high pressures
  - C) for big particles of complex construction
  - D) at a high temperature
223. An industrial method of obtaining metallic sodium is:
- A) a fused-salt electrolysis of NaCl
  - B) an electrolysis of the fused NaOH
  - C) an electrolysis of NaOH solution
  - D) an electrolysis of NaCl solution
224. The products of an important industrial catalytic combustion of ammonia in oxygen [Pt] are:
- A) nitric oxide NO and water
  - B) hydrazine and water
  - C) nitrogen and water
  - D) dinitric oxide ( $\text{N}_2\text{O}$ ) and water
225. A typical catalyst used in the synthesis of sulphur acid anhydride [VI] is:
- A) divanadium pentaoxide ,
  - B) oxygen
  - C) sulphur dioxide
  - D) sulphur trioxide
226. Sankey's graph is a:
- A) mass and/or energetic balance of a technological process shown as a stream graph
  - B) scheme of a technological installation
  - C) scheme of the exchange of mass and heat in a technological process
  - D) graphic display of the cost of manufacturing 1 kilo of the product

227. A degree of conversion is a:
- ratio of the amount of the substrate after the reaction to the initial amount of this substrate
  - ratio of the amount of the product to the final amount of the product
  - temporary efficiency of this process
  - total efficiency of this process
228. A certain process (e.g. an ammonia synthesis) runs its course with the use of a contact (solid) catalyst as well as a recirculation of the reagents which haven't undergone a reaction yet. Indicate which sentence is true:
- Total efficiency depends on the velocity of the process affecting the agent.
  - A degree of conversion on the catalyst (agent) is equal to the total efficiency of the process
  - Final efficiency of the process does not depend on the degree of conversion affecting the agent
  - Total efficiency on the size of change of the balance constant on the contact agent
229. During the reaction described by the equation  $X + NaOH \rightarrow Z + Y$ , from one ton of X substance (of a mole mass 100g/mole) 125 kilo Y substance (of a mole mass 50g/mole) were obtained. What is the percentage efficiency of the Y product synthesis?
- 25%
  - 50%
  - 12,5 %
  - No information about the mass of Z product, therefore it is not possible to calculate the efficiency
230. A criterion of the technological processes division into periodical and continuous processes is :
- organization of the process
  - the principle of energy retaining
  - no heat exchange with the surroundings
  - own costs of the product
231. Among the principles of a technological process performance there is no:
- principle of the most effective use of the difference of potentials
  - principle of energy recovering
  - principle of technological moderation
  - principle of the most efficient use of materials
232. A driving force in the processes of heat exchange is:
- difference of temperatures between the exchanging heat factors
  - concentration gradient of the reagents
  - value of the division coefficient
  - a number of degrees of freedom of the system
233. According to the principle of maximum use of materials , a process should be carried out so that occurrence of side products is minimized. Which method of obtaining chloromethane is compliant with this principle? :
- reaction of 1 kilomole chloride with 1 kilomole methane
  - reaction of chloride excess (e.g. 5 kilomoles) with 1 kilomole methane and recovery of the excess chloride which has not undergone the reaction
  - reaction of methane excess (e.g. 5 kilomoles) with 1 kilomole chloride and recovery of the excess methane which has not undergone the reaction
  - none of these methods

234. Indicate the appropriate ending of the sentence: A process of diminishing scale of a technological process is applicable to:
- A) testing changes/ improvements of a technological process
  - B) testing the resistance of the apparatus under pressure
  - C) determination of initial economic indicators of a technological process
  - D) hydrodynamic parameters calculation
235. Indicate the appropriate ending of the sentence: Heat convection is a process:
- A) of heat exchange connected with gas or liquid motion
  - B) consisting in heat transfer as a radiation energy
  - C) consisting in transferring heat in the vacuum
  - D) running against the gradient of temperatures
236. Which thermal process is responsible for bringing water in the kettle on the burner to boiling ?:
- A) free convection
  - B) radiation
  - C) filtration
  - D) electrolysis
237. Which unit operation can be carried out with the use of material counter-current?
- A) extraction
  - B) crystallization
  - C) filtration
  - D) electrolysis
238. One of heating/cooling methods is the use of heat regenerators. A heat regenerator is a :
- A) solid which continuously receives and releases thermal energy
  - B) substance which absorbs and releases heat as a result of a chemical reaction
  - C) material which absorbs or releases the excess heat as a result of phase transition
  - D) expedient flowing through a membrane heat exchanger, and bringing about cooling or heating
239. The speed of a contact-catalyzed reaction does not depend on:
- A) the period of the products' stay on the catalyst surface
  - B) the catalyst surface
  - C) specificity of catalyst
  - D) the period of the substrates' stay on the catalyst surface
240. The ammonia synthesis occurs according to the equation  $N_2 + 3H_2 \rightleftharpoons 2NH_3$  and is carried out with the use of a contact catalyst. It leads to the conclusion that , in order to obtain the maximum efficiency of the process of ammonia synthesis in the possibly shortest time, the process should be conducted:
- A) under increased pressure and possibly low temperature
  - B) under increased pressure and possibly high temperature
  - C) under lowered pressure and possibly high temperature
  - D) under lowered pressure and possibly low temperature

241. Which of the following reactions does not require the use of catalysts?
- A) obtaining soda with Solvay's method
  - B) oxidation of  $\text{SO}_2$  to  $\text{SO}_3$
  - C) ammonia synthesis
  - D) fat hardening
242. While selecting an organic liquid (which is insoluble in water) for the process of extraction from the water phase, one should mainly take into account:
- A) size of the distribution coefficient
  - B) density of this liquid
  - C) the rule of Gibbs' phases
  - D) Oswald's law of solutions
243. Distillation and rectification are:
- A) unit process
  - B) unit operations
  - C) reactions leading to obtainment of high-molecular compounds
  - D) industrial methods of organic synthesis
244. Which of the following methods will you propose as the most suitable for obtaining 100% ethanol on the commercial scale? :
- A) addition of benzene and rectification in the system : water- ethanol – benzene
  - B) fractional distillation in the environment of dry nitrogen
  - C) distillation in the presence of calcium chloride
  - D) rectification in the copper column in the hermetic apparatus
245. A commercial process of monomer obtainment for the production of polyethylene is:
- A) pyrolysis of petrols
  - B) pyrolysis of benzene
  - C) conversion of petrols
  - D) conversion of benzene
246. The process of disintegration of long hydrocarbon chains into shorter ones, which happens at a high temperature, is called:
- A) depolymerization
  - B) pyrolysis
  - C) isomerization
  - D) decarboxylation
247. The boiling point of products from the rig-piping distillation of crude oil increase in the row:
- A) petrol < kerosene < diesel oil < mazout
  - B) kerosene < diesel oil < petrol < mazout
  - C) diesel oil < kerosene < petrol < mazout
  - D) mazout < diesel oil < kerosene < petrol
248. At present, the raw material used to obtain petrol is :
- A) petroleum
  - B) natural gas
  - C) coal tar
  - D) brown coal

249. Cracking of hydrocarbons is conducted in order to:
- A) increase the participation of light ends
  - B) obtain liquid gas in the process of thermal decomposition of crude oil
  - C) isolate olefins hydrocarbons from petroleum
  - D) arrive at isomerization of paraffins hydrocarbons
250. At present, the most important industrial way of obtaining ethylene is :
- A) pyrolysis of petrols
  - B) hard coal gasification
  - C) petroleum refining
  - D) methane conversion
251. Petrol of high octane content is obtained in the process of:
- A) cracking of crude oil fraction
  - B) crude oil distillation
  - C) pyrolysis of crude oil fraction
  - D) hard coal coking
252. A mer is:
- A) a name for an element of polymeric chain
  - B) a name for a group of chemical compounds which create polymers
  - C) a product of depolymerization
  - D) a conventional name for a particle creating a colloid
253. Indicate which of the following products contains a vinyl polymer obtained as a result of free-radicals polymerization:
- A) a shopping bag made of PET (polyethylene terephthalate)
  - B) an electric socket (phenol-formaldehyde resin, the so called bakelite)
  - C) nylon tights
  - D) a scarf containing 50% polyacrylonitrile [ACN] and 50% cotton
254. During vulcanization the following process takes place:
- A) sulphur catalyzes free-of-radicals polymerization of isoprene
  - B) disulfide bridges emerge, similar to the ones in proteins
  - C) tiol groups are created
  - D) S<sub>8</sub> take shape of chains [S]<sub>x>8</sub> which occupy the space between the polyisoprenoid chains
255. One of the best nitrogen fertilizers is urea containing 46% nitrogen. On the commercial scale urea is obtained from the reaction:
- A) ammonia with carbon dioxide
  - B) nitric acid with ammonium salts
  - C) ethylenediamine with water
  - D) thermal decomposition of natural compounds
256. Indicate which of the sentences is true:
- A) Starch and wind belong to renewable sources of energy but crude oil and natural gas do not
  - B) Starch and natural gas belong to renewable sources of energy but crude oil and wind do not
  - C) Crude oil and natural gas are renewable sources of energy but starch and geothermics are not
  - D) Ethanol and natural gas are renewable sources of energy but crude oil and biomass are not

257. The main source of sulphur dioxide responsible for acid rains are fuel exhausts. The most sulphur is in:
- A) hard coal
  - B) heating oil
  - C) diesel oil
  - D) city gas
258. Laboratory organic waste is sorted out into a group containing halogen derivatives and a group not containing them. Such a division results from:
- A) another way of chemical utilization of both kinds of waste
  - B) necessity of recovery of waste containing halogenorganic compounds
  - C) probability of reacting of halogen derivatives' compounds with other organic compounds
  - D) other kinds of chemical regeneration of both kinds of waste
259. Water hardness by the occurrence of the following compounds in water:
- A) lime and magnesium salts
  - B) potassium and sodium salts
  - C) phosphates
  - D) ferric and manganese salts
260. Which of the following compounds are substances which reduce water surface tension?
- A) sodium salts of fatty acids
  - B) magnesium salts of fatty acids
  - C) lime salts of fatty acids
  - D) glycerol esters
261. Crude oil (petroleum) is a source of:
- A) diesel liquid and energetic fuels
  - B) raw materials for petrochemical synthesis
  - C) petrol, kerosene, diesel oil
  - D) natural gas and brown coal
262. The origin of crude oil (petroleum) can be best explained by:
- A) organic theory
  - B) presence of chlorophyll and hemin derivatives
  - C) inorganic theory
  - D) presence of methane
263. The most accurate evaluation of petroleum quality can be conducted on the basis of:
- A) technological classification
  - B) basic physicochemical designations
  - C) geological classification
  - D) classification based on density
264. Which of the options of petroleum refining distinguishes itself with the widest range of petroleum and petrochemical products?
- A) petrochemical
  - B) fuel option
  - C) fuel-oil
  - D) fuel with deepened petroleum refining

265. In the process of atmospheric distillation one can obtain:
- A) dry and liquefied petroleum gas
  - B) kerosene and diesel oil
  - C) products boiling under 350°C
  - D) vacuum distillates
266. Most thermal cracking reactions happens:
- A) according to the radical mechanism
  - B) by the use of a catalyst
  - C) carbonium ion, carbo-cation
  - D) in temperatures of over 800°C
267. Catalytic cracking reactions happen:
- A) by the use of a catalyst of acid character
  - B) through radicals
  - C) through a carbo-cation
  - D) in temperatures of over 800°C
268. In the processes of hydrofining of petroleum products the following are mainly removed:
- A) combinations S, O, N
  - B) aromas
  - C) paraffins
  - D) naphthenes
269. To the solvent refining of petroleum products the following are used:
- A) furfural , phenol
  - B) solvents of a big dipole point
  - C) arenes
  - D) cycloalkanes
270. The aim of catalytic reforming is to:
- A) obtain high aroma petrol fractions
  - B) mainly dehydrogenation of cycloalkanes to aromas
  - C) catalytic decomposition of C-C combinations
  - D) refining of petroleum fractions in the boiling temperature over 200°C
271. Asphaltene-resinous substances can be extracted from petroleum or its fractions by:
- A) the use of light paraffin solvents
  - B) the use of aromatic solvents
  - C) heating the solution
  - D) two answers are correct
272. During thermal cracking of a petroleum fraction, the basic process consists in:
- A) disruption of C-C bonds of hydrocarbons
  - B) catalytic cleavage of C-C bonds
  - C) reaction of carbocation occurrence
  - D) all the answers are correct
273. In order to extract solid paraffins from a petroleum fraction, presently the following are used:
- A) crystallization from a solution by temperature lowering with the use of appropriate solvents
  - B) additive crystallization with the use of carbamide

- C) filtering of a petroleum fraction heated to an appropriate temperature
  - D) rinsing the fraction with distilled water at a temperature of 40-50°C
274. The occurrence of oil-water emulsions in petroleum is facilitated by:
- A) the presence of surface-active substances
  - B) heating of the water – petroleum system
  - C) the viscosity increase
  - D) slight lowering of the temperature of petroleum containing dissolved water
275. Petroleum fractional content :
- A) informs about the content of a fraction with a defined range of temperatures of boiling
  - B) informs what products can be obtained from it
  - C) can be determined by distillation
  - D) informs about the origin of petroleum
276. The durability of C-C bonds as compared to the durability of C-H bonds is:
- A) smaller
  - B) equal
  - C) an order of magnitude greater
  - D) an order of magnitude lower
277. If 60% pale products were obtained in the process of rig-piping distillation, then petroleum refining is determined as:
- A) deep
  - B) quite deep
  - C) deepened
  - D) shallow
278. Mazout is a residue after the following stage of rig-piping distillation:
- A) atmospheric distillation
  - B) stabilization
  - C) vacuous distillation
  - D) seasoning
279. Light petrol belongs to the products of rig-piping distillation known as:
- A) light
  - B) dark
  - C) mazout
  - D) soft asphalt
280. The time of drops fall in the oil-water emulsion division is proportional to:
- A) the medium viscosity
  - B) temperature
  - C) electric field intensity
  - D) the square of the diameter of a drop
281. An octane number is a percentage content in a model mixture (composition) of:
- A) isooctane
  - B) benzene
  - C) n-butane
  - D) 1-n-octanol

282. A cetane index is a measure of the following fuel qualities:
- A) ability of self-ignition
  - B) resistance to self-ignition
  - C) content of lead tetraethyl
  - D) viscosity
283. Caloric value depends on the fuel content of:
- A) C, H, O
  - B) C, Si, Mg
  - C) C, He, Po
  - D) CO, Pb, Ar
284. 5% sulfated crude oil can be included in:
- A) high-sulfuric oils
  - B) low-sulfuric oils
  - C) oils of average content of sulfur
  - D) sulfuric oils
285. Electrodehydrators are an element of installation for:
- A) drying and desalination of petroleum
  - B) degassing of petroleum
  - C) vacuous distillation of petroleum
  - D) forcing petroleum down the installation
286. On the basis of Newman's rule one measures:
- A) non-dimensional temperature
  - B) absolute temperature
  - C) absolute temperature or temperature in Celsius degrees
  - D) only temperature in Celsius degrees
287. There is a dependence for heat penetration in conditions of forced convection:
- A)  $Nu = f [Re, Pr]$
  - B)  $Nu = f [Gr, Pr]$
  - C)  $Nu = f [Re, Gr]$
  - D)  $Nu = f [Re, Gr, Pr]$
288. The temperature of one edge of a flat wall is equal to  $530^{\circ}\text{C}$ , and in half of the distance between two edges the temperature is of  $520^{\circ}\text{C}$ . The thickness of the wall is equal to 0.1m. Density of the material used for the wall is equal to  $1000\text{kg/m}^3$ , the coefficient of thermal conduction is  $1\text{W/[mK]}$ . Thermal waste is in  $[\text{W/[m}^2\text{K]}]$  and in this case it is equal to:
- A) 200
  - B) 100
  - C) 10
  - A) 20

289. In the case of thermal conduction through a wall consisting of 1cm thick steel layer [the heat conduction coefficient is  $45\text{ W}/[\text{mK}]$ ], 10cm copper layer [ $384\text{ W}/[\text{mK}]$ ], 10cm aluminium layer [ $203\text{ W}/[\text{mK}]$ ], 1cm tin layer [ $63\text{ W}/[\text{mK}]$ ], the biggest fall of temperature will take place on the layer of:
- A) aluminium
  - B) copper
  - C) tin
  - D) steel
290. The coefficient of heat conduction:
- A) can be used as a criterion of division of materials into conductors and non-conductors
  - B) is opposite of the conduction resistance
  - C) determines susceptibility of a liquid to a convective heat transport
  - D) is always smaller than a unit
291. Choose the best heat conductor from the list:
- A) graphite
  - B) peat
  - C) brown coal
  - D) hard coal
292. During heating of a cylinder of a diameter of 5cm and a height of 7cm, for the first 15 minutes of the process there was a change of non-dimensional temperature of about 0,25 in the centre of the base. Will a subsequent change be of the same value?
- A) longer than 15 min.
  - B) it can't be determined only on the basis of these data
  - C) also 15 min.
  - D) shorter than 15 min.
293. A flat wall made of material of the heat conduction coefficient  $0.3\text{ W}/[\text{mK}]$  is 0.6 m thick. Resistivity of heat conduction through this wall in  $[[\text{m}^2\text{K}]/\text{W}]$  will be:
- A) 2
  - B) 10
  - C) 0.5
  - D) 5
294. During cooling after 25 minutes of the process, the non-dimensional temperature of a body is equal to 0.3. Initially the body had a temperature of  $120^\circ\text{C}$ , the temperature of the surroundings is constant and is equal to  $20^\circ\text{C}$ . What is the temperature of the body measured in Celsius degrees?
- A) 50
  - B) 30
  - C) 60
  - D) 70
295. The Nusselt number is
- A) a number used for calculating the coefficient of heat penetration
  - B) an analog of the Biot number for the processes of heat penetration
  - C) a determining number
  - D) a name for the product of  $Re$  and  $Pr$

296. During heating a sphere for the first 2 minutes of the process there has been an increase of the temperature by  $2^{\circ}\text{C}$  in its centre. Will the increase by  $2^{\circ}\text{C}$  last?:
- for longer than 2 minutes
  - shorter than 2 minutes
  - 2 minutes
  - The problem is too complicated to provide one unambiguous answer
297. During heat penetration in the condition determined by a multi-layer flat wall [5 layers of a thickness of 10 cm each, the heat conduction coefficients :  $0.1\text{W}/[\text{mK}]$ ,  $0.2\text{ W}/[\text{mK}]$ ,  $50\text{ W}/[\text{mK}]$ ,  $0.2\text{ W}/[\text{mK}]$ , and  $0.1\text{ W}/[\text{mK}]$ . From water [the coefficient of heat penetration of  $250\text{ W}/[\text{m}^2\text{K}]$ ] to air [the coefficient of heat penetration of  $25\text{ W}/[\text{m}^2\text{K}]$ ] . The heat penetration coefficient in  $\text{W}/[\text{m}^2\text{K}]$  will be equal to:
- less than 25
  - certainly bigger than 250
  - between 25 and 250
  - the data are insufficient to evaluate
298. Density of the heat stream conducted through a flat wall is equal to  $10\text{ W}/(\text{m}^2)$ . The temperature of one edge of the wall is equal to  $100^{\circ}\text{C}$ , and conduction resistivity is  $10\text{ [m}^2\text{K}]/\text{W}$ . The temperature ( in Celsius degrees) of the second edge will be equal to:
- 0
  - 200
  - 100
  - 50
299. The calculated value of the linear coefficient of heat penetration for a cylindrical wall is equal to  $10\text{W}/[\text{mK}]$  and the difference between temperatures of expedients is equal to  $100^{\circ}\text{C}$ . In this case, thermal waste will be:
- about  $3140\text{ W}/\text{m}$
  - $1000\text{ W}/\text{m}$
  - $10\text{ W}/\text{m}$
  - about  $31.4\text{ W}/\text{m}$
300. Heat transfer by natural convection in open space is described by equation:
- $\text{Nu}=\text{f}[\text{Gr}, \text{Pr}]$
  - $\text{Nu}=\text{f}[\text{Re}, \text{Pr}]$
  - $\text{Nu}=\text{f}[\text{Re}, \text{Gr}, \text{Pr}]$
  - $\text{Nu}=\text{f}[\text{Re}, \text{Gr}]$
301. One-dimensional transient processes of thermal conduction can be described by equation:
- $Y=Y[X, \text{Bi}, \text{Fo}]$
  - $Z=F[X, Y, \text{Bi}]$
  - $Y=X\text{BiFo}$
  - $Y=Y[\text{Bi}, \text{Fo}]$
302. For the data set  $\text{Re}=1000$ ,  $\text{Nu}=10$ ,  $\text{Pr}=5$ ,  $I=0.1\text{m}$ , thermal conductivity coefficient= $0.1\text{ W}/(\text{mK})$  , the value of the heat transfer coefficient in  $\text{W}/[\text{m}^2\text{K}]$  equals:
- 10
  - 0.1
  - 0.001
  - 5

303. In liquids, natural convection:
- A) always occurs
  - B) does not occur when forced convection takes place
  - C) does not occur on the moon
  - D) occurs, provided that it is simultaneously accompanied by conduction
304. Which of the below listed terms are synonymous:
- A) heat transfer and taking up the heat
  - B) thermal conduction and taking up the heat
  - C) heat transfer and heat transmission
  - D) thermal conduction and heat transmission
305. For transient processes of thermal conduction, flux density is directly proportional to:
- A)  $-\text{grad } T$
  - B) the difference between the bodies' temperature
  - C)  $\text{grad } T$
  - D)  $-\text{average temperature of the system}$
306. Having available appropriate fluxes and concentrations, mass flux of component A can be represented as:
- A) a product of a mass fraction of the component A and the mass rate of the mixture flow
  - B) a product of the mass ratio of the component A and the inert molar flow rate
  - C) a product of the component A volume fraction and the mass rate of the inert flow
  - D) a product of a molar fraction of the component A and the mixture molar flow rate
307. The first Fick's law can be applied to describe:
- A) equimolar diffusion
  - B) unidirectional diffusion through inert
  - C) only equimolar convection
  - D) transient diffusion
308. Maxwell's law describes the case of:
- A) determined diffusion of a component diffusing through "other" components which can either diffuse in different directions or not move at all
  - B) transient diffusion
  - C) only of a component diffusing through "other", nonmoving components
  - D) determined convection
309. Which of the below mentioned is not a stage of mass penetration according to the two bordering layers theory:
- A) mass penetration to the surface of the interface contact, mass conduction through the surface of the interface contact, mass penetration into the second phase core
  - B) convection from the liquid phase core to the laminar border layer, diffusion through the border layer, conduction through the mirror, diffusion through the border layer of gaseous phase, convection to the gaseous phase core
  - C) convection from the gaseous phase core to the laminar border layer, diffusion through the border layer, conduction through the mirror, diffusion through the border layer of the liquid phase, convection to the liquid phase core

D) diffusion from the phase core to the contact phase surface, convection through the mirror, diffusion to the second phase core

310. Raoult's law states that:

A) partial pressure of a liquid mixture component over this mixture equals the product of a molar fraction of this component in the solution and its saturated vapour pressure

B) partial pressure of a liquid mixture component over this mixture equals the product of Henry's constant and a molar fracture of this component in the solution

C) partial pressure of a liquid mixture component over this mixture equals the sum of partial

pressures of all the components

D) partial pressure of a liquid mixture component over the mixture is inversely proportional to a molar fraction of this component in the solution

311. It is true that the rectification process:

A) consists in steam enrichment in a more volatile component during a counter-current contact of the liquid with the steam, with a simultaneous exchange of mass and heat

B) occurs in all types of distillation stills

C) requires that the substances undergoing this process do not mix with one another

D) takes place in evaporators

312. Extraction is a process, during which:

A) liquid mixture is separated by means of a selective solvent

B) solid mixture is separated by means of a selective solvent

C) one of the gas components passes to the selective solvent

D) the original solvent vapours become enriched in a more volatile component

313. If we adopt the following notation:  $x$ - mass fraction of the extracted component,  $S, C$ - the mass of the raw material and of the secondary solvent supplied for the process,  $E, R$ - the mass of the extract and the raffinate obtained in the process,  $M$ - the mass of the mixture in the extractor, then the correct formula for the single-step extractor is:

A)  $M \cdot x_{AM} = E \cdot x_{AE} + R \cdot x_{AR}$

B)  $S \cdot x_{AS} + C \cdot x_{AC} = E \cdot x_{AE} + R \cdot x_{AR}$

C)  $S \cdot x_{AS} = M \cdot x_{AM} + C \cdot x_{AC}$

D)  $E \cdot x_{AE} = S \cdot x_{AS} - R \cdot x_{AR}$

314. If the composition of vapours leaving the distillation column  $y_{\text{mol}A} = 0.822$  and that of the raw material  $x_{\text{mol}A} = 0.5$ , and the equilibrium line equation  $y^*_{\text{mol}A} = 0.311x_{\text{mol}A} + 0.7707$ , then the composition of the liquid used up in the equilibrium distillation is:

A)  $0.165 \text{ kmol}_A/\text{kmol}_{\text{mix}}$

B)  $0.027 \text{ kmol}_A/\text{kmol}_{\text{mix}}$

C)  $0.5 \text{ kmol}_A/\text{kmol}_{\text{mix}}$

D)  $0.392 \text{ kmol}_A/\text{kmol}_{\text{mix}}$

315. If  $t$  denotes the process time,  $m$  the mass of the substance in the system,  $m_1$  the flow of mass entering the system,  $m_2$  the flow of mass leaving the system and  $x_A, x_{A1}, x_{A2}$  denote successive concentrations [mass fractions] of the component balanced respectively in: the system, the incoming mass flow and the mass flow leaving the system, then the correct equation for the material balance of the component A for continuous processes, without a chemical reaction, is:

- A)  $d[m \cdot x_A]/d\tau = m_1 \cdot x_{A1} - m_2 \cdot x_{A2}$
- B)  $dm/d\tau = m_1 - m_2$
- C)  $d[m \cdot x_A]/d\tau = m_1 \cdot x_{A1} - m_2 \cdot x_{A2} - dm/d\tau$
- D)  $dm/d\tau = m_1 \cdot x_{A1} - m_2 \cdot x_{A2}$

316. Molar density of the component A diffusion flux is:

- A) the number of the component A moles which diffuse in a unit of time through unitary surface, perpendicular to the direction of the component's movement
- B) the number of the component A moles which diffuse in a unit of time through the surface perpendicular to the direction of the component's movement
- C) the number of the component A moles that diffuse in any time through unitary surface perpendicular to the direction of the component's movement
- D) the number of the component A moles which are transferred in a unit of time, in the convection manner, through elementary surface perpendicular to the direction of the component's movement.

317. Mass transfer is the transport of mass between:

- A) the core of the liquid and the interface surface
- B) the cores of two contacting liquids
- C) gaseous phase core and liquid phase core
- D) any two chosen layers in one phase

318. In practice, mass transfer coefficients are calculated :

- A) from criterion equations
- B) as a sum of the diffusion coefficient and the coefficient of convection transmission proportionality
- C) as the inverse of the convection resistance coefficients
- D) the transfer coefficients cannot be calculated

319. If  $Y_1, Y_2$  denote mass ratio of the component absorbed in the gas flow at the adsorber inlet and outlet respectively,  $X_1, X_2$  – the mass ratio of the component absorbed in liquid flow at the adsorber outlet and inlet respectively,  $L_i G_i$  – the mass flow of liquid and gas inert, then the correct formula for the material balance of a counter-current absorber [ideal piston flow of both phases] is :

- A)  $L_i \cdot [X_1 - X_2] = G_i \cdot [Y_1 - Y_2]$
- B)  $G_i \cdot [X_1 - X_2] = L_i \cdot [Y_1 - Y_2]$
- C)  $L_i \cdot [X_2 - X_1] = G_i \cdot [Y_1 - Y_2]$
- D)  $L_i \cdot [X_1 - X_2] = G_i \cdot [Y_2 - Y_1]$

320. What does the term *degree of absorption* denote:

- A) the ratio of the concentration change of the component absorbed in the gas to the concentration of the component adsorbed in the incoming flow
- B) coefficient describing to what extent an interface formed on the surface of the absorber filling
- C) the ratio of the active surface filling to the surface filling
- D) the ratio of a liquid inert flow to a gas inert flow

321. Which of the following statements concerning convective mass transfer are true:

- A) Convective mass transfer in liquids and gases may occur as a result of particles being lifted by the velocity field
- B) Natural convection takes place when movement is the result of physical phenomena, e.g. gravitation
- C) Forced convection takes place when liquid particles are given velocity in a mechanical way, e.g. using pumps

D) Convective transfer is essential for diffusion processes.

322. Equilibrium step of mass exchange is a term:

- A) used when calculating stepping column plates apparatus
- B) Referring to the section in the apparatus where the concentrations of streams leaving this section are in equilibrium
- C) used to calculate the density of the diffusing mass flow
- D) used to calculate the coefficients of mass transfer

323. In general, the mass transfer flow can be expressed as a product of the following quantities:

- A) The coefficient of mass transfer, surface and the driving force of the mass transfer process
- B) the coefficient and the driving force of the mass transfer process
- C) the diffusion coefficient, the surface of mass exchange and the height difference of the filling layer
- D) the transfer coefficient, the surface of mass exchange and the cross-section of the apparatus

324. Which of the statements concerning the distillation process are true:

- A) The difference of the boiling points of the mixture components undergoing distillation is essential for their separation
- B) The change of phase composition enables the mixture separation through distillation
- C) Distillation is the separation of a liquid mixture by means of a selective solvent
- D) Addition of a selective solvent is essential during the process

325. The height equivalent to a theoretical plate is:

- A) a hypothetical place in a column, where the equilibrium between the concentrations of the flows leaving the place is established
- B) the height of the filling layer in the column, which in action [mass exchange] is equivalent to one theoretical plate
- C) the height of the filling layer equal to the height of the liquid on the plate
- D) the height of the filling built into the column after taking into account the coefficient of surface utilization

326. In a given coal basin, moving from the upper coal beds to the lower coal beds, one can observe:

- A) an increase in coal rank, expressed by an increase in carbon content and a decrease in volatile matter content.
- B) an increase in coal rank, expressed by a decrease in carbon content and an increase in volatile matter content
- C) a decrease in ash, sulfur, phosphorus, chlorine and alkalies content
- D) an increase in ash, sulfur, phosphorus, chlorine and alkalies content

327. Coal rank ( coalification degree) means:

- A) the place of coal in the coalification range from soft brown coal to anthracite, indicating its geological stage, as well as physical and chemical qualities resulting from it
- B) the loss of coal mass during the coalification process, expressed as % of the mass of the plant material from which coal was formed
- C) quantitative measure of the organic matter content in coal
- D) a synonym of the volatile matter content in coal

328. The coalification degree can be determined by:
- A) the carbon content , the volatile matter content and the reflectance of vitrinite R
  - B) the carbon content, the volatile matter content and the vitrinite content
  - C) the carbon content, the volatile matter content and the intertinite content
  - D) the carbon content, the volatile matter content and the organic matter content
329. Along with the increase in coal rank:
- A) the carbon content increases significantly , while the content of oxygen and hydrogen decreases
  - B) the carbon and oxygen content increases significantly, while the hydrogen content decreases
  - C) the carbon and hydrogen content increases significantly , while the oxygen content decreases
  - D) the content of carbon, oxygen and hydrogen increases significantly
330. The ash content in air-dried coal is:
- A) higher than in coal as received
  - B) lower than in coal as received
  - C) higher than in dry coal
  - D) equal to the ash content in dry coal
331. The total moisture content in solid fuels is in the range:
- A) up to 90% in fresh peat, up to 50% in fresh wood, up to 55% in soft brown coal and up to 20% in hard coal
  - B) up to 50% in fresh peat, up to 30% in fresh wood, up to 15% in soft brown coal, and up to 5% in hard coal
  - C) Up to 50% in fresh wood, up to 30% in fresh peat, up to 15% in soft brown coal, and up to 5% in hard coal
  - D) Up to 90% in fresh wood, up to 50% in fresh peat, up to 55% in soft brown coal, and up to 20% in hard coal
332. Ash is:
- A) a solid residue after the combustion of a solid fuel under temperature and time conditions specified by Polish or ISO standards, expressed in % of the initial mass of the sample
  - B) solid residue after the pyrolysis of a solid fuel under temperature and time conditions specified by Polish or ISO standards, expressed in % of the initial mass of the sample
  - C) a synonym of coal mineral substance
  - D) the mass loss of a sample after the combustion of a solid fuel under temperature and time conditions specified by Polish or ISO standards, expressed in % of the initial mass of the sample
333. According to Polish standards the volatile matter content is defined as:
- A) the mass loss of a solid fuel sample after pyrolysis under the conditions specified in Polish and ISO standards, expressed in % of the initial mass of the sample and reduced by the moisture content in the analytical state of the sample
  - B) the mass loss of a solid fuel sample after pyrolysis under conditions specified in Polish and ISO Standards, expressed in % of the initial mass of the sample
  - C) ) the mass loss of a solid fuel sample after pyrolysis under conditions specified in Polish and ISO Standards, expressed in % of the initial mass of the sample and reduced by the ash content in the analytical state of the sample
  - D) the difference between the fixed-carbon content and the ash content under conditions specified in Polish and ISO Standards

334. According to petrographic definition, coal is:
- A) a combustible sedimentary rock, formed from plant residues compressed by the cover layer
  - B) a combustible metamorphic rock, formed from plant residues compressed by a cover layer
  - C) a combustible magmatic rock, formed from animal and plant residues compressed by a cover layer
  - D) not a rock
335. The remnants of plant fragments from which coal was formed, differing in chemical, physicochemical and mechanical properties, are called:
- A) macerals
  - B) carbominerites
  - C) microlithotypes
  - D) lithotypes
336. Bi- or multimodal type of the reflectance diagram of coking coal delivered to a coking plant indicates that:
- A) it is a blend of coals from two or more mines
  - B) it is coal of a low rank
  - C) this is coal of a high rank
  - D) the coal comes from one coal bed
337. While examining the dilatometric properties of coal by Polish Standards the following indices are determined:
- A) maximal contraction [a], maximal dilatation [b], softening temperature [tI], the temperature of contraction [tII], the temperature of dilatation [tIII] and the temperature range of coal plasticity [tI ÷ tIII]
  - B) minimal contraction [a], maximal dilatation [b], softening temperature [tI], the temperature of contraction [tII], the temperature of dilatation t [tIII] and the temperature range of plasticity [tI ÷ tIII]
  - C) maximal contraction [a] and maximal dilatation [b]
  - D) total contraction [a], total dilatation [b], the softening temperature [t1], the temperature of maximal fluidity [tmax], and the temperature of resolidification [t3]
338. According to Polish classification, solid fuels are described by a two-digit code number, and:
- A) the first digit denotes the group of the fuel and the second one the position of the fuel in the group
  - B) the first digit denotes the position of the fuel in the group and the second one the group of the fuel
  - C) the first digit denotes the group of the fuel and the second one is connected with the ash content in the fuel
  - D) the first digit denotes the group of the fuel and the second one is connected with the gross calorific value of the fuel
339. Polish classification of hard coals by types:
- A) is based on the so-called primary features of coal
  - B) is based on the so-called secondary features of coal
  - C) is based both on the primary and secondary features of coal
  - D) is based neither on the primary nor on the secondary features of coal

340. According to Polish standards, the criteria of hard coal classification include:
- A) the volatile matter content ( $V^{daf}$ ), the agglutination ability by Roga (RI), the dilatation index (b), the swelling index SI and the gross calorific value ( $Q_s^{daf}$ )
  - B) the volatile matter content ( $V^{daf}$ ), the agglutination ability by Roga (RI), the contraction index (a), the swelling index (SI) and the gross calorific value ( $Q_s^{daf}$ )
  - C) the volatile matter content ( $V^{daf}$ ), the agglutination ability by Roga (R), the dilatation index (b), the maximal coal fluidity index ( $F_{max}$ ), and the gross calorific value ( $Q_s^{daf}$ )
  - D) the volatile matter content ( $V^{daf}$ ), the agglutination ability by Roga RI, the contraction index (a), maximum fluidity index ( $F_{max}$ ) and the gross calorific value ( $Q_s^{daf}$ )
341. According to the classification of coal ranked by assortments, the correct order of the assortments starting from the biggest to the smallest is as follows:
- A) rounds of coal, cobble, nut coal, fine coal, coal dust
  - B) nut coal, rounds of coal, cobble, fine coal, dust
  - C) rounds of coal, nut coal, cobble, fine coal, coal dust
  - D) rounds of coal, cobble, fine coal, nut coal, coal dust
342. The technological classification of steam coal for the purpose of power production specifies :
- A) classes [ depending on the lower calorific value and the ash content in coal as received], sorts [ depending on the class and the size of grains] and forms [ depending on the transport ability of fine coals and coal slurries]
  - B) classes [ depending on the lower calorific value and the total moisture content in coal as received ], sorts [ depending on the ash content in coal as received] and forms [depending on the class and the size of grains]
  - C) classes [depending on the ash content in coal as received], sorts [depending on the class and the size of grains]and forms [depending on the transport ability of fine coals and coal slurries]
  - D) classes [depending on the lower calorific value and ash content in coal as received], sorts [depending on the transport ability of fine coals and coal slurries] and forms [depending on the class and the size of grains]
343. the classes of hard coke for the coking process are denoted by a double-digit code number describing:
- A) the ash content in dry coal ( $A^d$ ) and the total moisture content in coal as received ( $W^r_t$ )
  - B) the Roga index (RI) and the swelling index (SI)
  - C) the lower and upper size limit of coal grains
  - D) the ash content in coal as received and the total moisture content in dry coal ( $W^d_t$ )
344. The code numbers of Polish brown coal classification for the purpose of power production refer to:
- A) the ash content and the lower calorific value of coal as received, the total sulfur content in dry coal, the sand content, the fibrous xylith content and the melting temperature of coal ash
  - B) the moisture content, the lower calorific value of coal as received, the total sulfur content in dry coal and the melting temperature of the coal ash
  - C) the ash content and the lower calorific value of coal as received , as well as the content of total sulfur, the content of phosphorus, chlorine and alkalis in dry coal

D) the ash content and the lower calorific value of coal as received, the content of total sulfur, the content of phosphorus, chlorine and alkalis in dry coal as well as the yield of low temperature tar

345. A typical technological system of a coking coal preparation plant is represented by the following sequence:

- A) crushers-> dense medium washer -> jig washer -> flotation
- B) crusher -> jig washer -> dense medium washer-> flotation
- C) dense medium washer -> crushers -> jig washer -> flotation
- D) crushers > flotation -> jig washer -> dense medium washer

346. Coal homogenization in a coking plant is based on:

- A) the use of so-called two heaps economy and a proper way of stacking and unstacking of heaps
- B) a proper way of stacking and unstacking of heaps , as well as crushing and grinding of coals
- C) the use of so-called two heaps economy and the crushing and grinding of coals
- D) the crushing and grinding of coals as well as the proportioning of coal blends according to the strictly determined recipes

347. Factors contributing to the oxidation of coals in the stock are i.a.:

- A) a low coal rank, its small grain size, high pyrite content
- B) a high coal rank, its large grain size, low pyrite content
- C) a low coal rank, its small grain size , low pyrite content
- D) a high coal rank, small grain size, high pyrite content

348. Which of the below mentioned systems requires the smallest number of crushers to grind the same amount of coking coal:

- A) coal blend grinding
- B) selective grinding
- C) single-component grinding
- D) grinding of a groups of components

349. In order to evaluate the homogeneity of a coal blend for coke production, the following parameters are used::

- A)the mean standard deviation of the volatile matter content in the point samples taken from the cross-section of the layer of coal blend on the conveyor belt
- B) the mean standard deviation of volatile matter content in the point samples taken from the longitudinal section of the layer of coal blend on the conveyor belt
- C) the mean standard deviation of moisture content in the point samples taken from the cross-section of the layer of coal blend on the conveyor belt
- D) the mean value of the volatile matter content in the point samples taken from the cross-section of the layer of coal blend on the conveyor belt

350. The bulk density of the coal charge in the oven increases according to the following sequence:

- A) the traditional top charging system> top charging of the pre-heated coal charge > top charging of the partially briquetted coal charge >stamping of the wet coal charge > stamping of the pre- heated coal charge
- B) the traditional top charging system > stamping of the wet coal charge > top charging of the pre- heated coal charge >top charging of the partially briquetted coal charge > stamping of the wet coal charge
- C) the traditional top charging system >stamping of the wet coal charge > top charging of the pre-heated coal charge >s tamping of the pre-heated charge >

top charging of the partially briquetted coal charge > stamping of the wet coal charge

D) the traditional top charging system > top charging of the pre-heated coal charge > top charging of the partially briquetted coal charge > stamping of the pre-heated coal charge > stamping of the wet coal charge

351. The layer-type of the coking process in a commercial chamber represents the following sequence:

A) wet coal blend > dry coal blend > plastic layer > semi-coke > coke

B) dry coal blend > plastic layer > semi-coke > coke

C) wet coal blend > dry coal blend > semi-coke > plastic layer > coke

D) wet coal blend > dry coal blend > semi-coke > coke > plastic layer

352. Under conditions of the commercial coking chamber, heated charge exerts the greatest force on the chamber walls:

A) after 2/3 of coking time, when two plastic layers meet in the tar seam axis

B) directly after charging the chamber with the coal blend

C) directly before discharging coke from the chamber

D) after 1/3 of the coking time, as a result of the total moisture evaporation

353. In a correctly operated coke battery, the gas pressure in ovens is:

A) always positive and towards the end of the coking process its value measured next to the oven floor should not be lower than  $\pm 5$  Pa

B) always negative and towards the end of the coking process its value measured next to the oven floor should not be higher than  $\pm 5$  Pa

C) always positive and towards the end of the coking process its value measured next to the oven floor should not be lower than  $\pm 50$  Pa

D) always positive and towards the end of the coking process its value measured below the oven ceiling should not be lower than  $\pm 5$  Pa

354. The task of the coke oven battery (COB) binding is to:

A) protect the refractory during starting-up and operating of the COB

B) protect the refractory against the influence of high temperature

C) transfer thermal and mechanical stresses to the ground

D) protect the refractory against excessive emission of heat into the atmosphere.

355. The set of machines co-working with a top charging coke oven battery includes:

A) a pushing machine, a charging car, a guide car and a coke quenching car

B) a charging car, a guide car and a coke quenching car

C) a stamp coal charging machine, a charging car, a guide car and a coke quenching car

D) a stamp coal charging machine, a guide car and a coke quenching car

356. The following layout describes a typical arrangement of a by-products department:

A) a gas collecting main -> a primary cooler -> exhausters -> an electrofilter -> an ammonia recovery plant -> a final cooler -> a crude benzol recovery plant -> a desulphurization installation,

B) a gas collecting main -> a primary cooler -> exhausters -> an electrofilter -> a final cooler -> an ammonia recovery plant -> a crude benzol recovery plant -> a desulphurization installation

C) a gas collecting main -> a desulphurization installation -> exhausters -> an electrofilter -> an ammonia recovery plant -> a final cooler -> a crude benzol recovery plant -> a primary cooler

D) a gas collecting main -> a primary cooler -> exhausters -> an electrofilter -> an ammonia recovery plant -> a desulphurization installation -> a crude benzol recovery plant -> a final cooler

357. The overall efficiency of a coke screen is calculated based on a formula which includes:

- A) the content of the required grain size in the feed, sifted coke and screened coke
- B) the content of the required grain size in sifted coke and screened coke
- C) the content of the undesired grain size in sifted coke and screened coke
- D) the theoretical energy demand and its real consumption to spread 1 Mg of coke

358. The NSC ( Nippon Steel Co.) method determines:

- A) CSR index, defining coke strength after the reaction with CO<sub>2</sub>, and CRI index, defining the examined coke reactivity
- B) CRI index, defining coke strength after the reaction with CO<sub>2</sub>, and CSR coefficient, defining the examined coke reactivity
- C) CRI index, defining coke strength after the reaction with CO<sub>2</sub>, CSR index, defining the examined coke reactivity, and its sieve composition
- D) CSR index, defining coke strength, after the reaction with CO<sub>2</sub>, CRI index, defining the the reactivity, and the size distribution of the examined coke

359. Which reaction is positively affected by an increase in pressure and a decrease in temperature:

- A)  $C + 2H_2 \rightleftharpoons CH_4$
- B)  $CO + H_2O \rightleftharpoons CO_2 + H_2$
- C)  $C + CO_2 \rightleftharpoons 2CO$
- D)  $CH_4 + H_2O \rightleftharpoons CO + 3H_2$

360. Coal dust in a water suspension is dosed into a gasifier based on the method of::

- A) Texaco
- B) Shell
- C) Siemens
- D) Koppers-Totzek

361. The dwell time of coal inside a gasifier is the shortest in case of:

- A) an entrained bed
- B) a moving bed
- C) a fluidized bed
- D) it is independent of the type of bed

362. Atomic ratio of hydrogen to oxygen (in the presence of heteroatoms of O and N ] for coal and liquid fuels is equal to:

- A) in H/C coals about 0.7 ÷ 0.8, while in crude oil and petrol 1.75 ÷ 1.95
- B) in H/C coals about 1.75 ÷ 1.95 while in crude oil and petrol 0.7 ÷ 0.8
- C) in H/C coals about 1 ÷ 1.5 while crude oil and petrol 2 ÷ 2.5
- D) in H/C coals about 2 ÷ 2.5 while in crude oil and petrol 1 ÷ 1.5

363. Synthesis gas is:

- A) the gas used as raw material for chemical syntheses
- B) the waste gas produced in industrial synthesis
- C) the gas used for the process of direct coal liquefaction
- D) any synthetic gas

364. Orthocoking coal is not used for combustion in grate furnaces because:

- A) it agglomerates on a grate and losses of the fuel due to incomplete combustion are very high
  - B) its calorific value is too low
  - C) it requires too much air for combustion
  - D) furnace black is formed during combustion
365. The process of ash melting is characterized by the temperatures of:
- A) initial deformation, softening, melting, flow
  - B) softening, maximum fluidity, resolidification
  - C) softening, contraction, dilatation
  - D) ignition, melting, resolidification
366. Energy gap of the modern broadband semiconductor – gallium nitride, GaN, equals:
- A) 3.4eV
  - B) 1.1 eV
  - C) 0.5 eV
  - D) 6.2 eV
367. On the basis of which conductors do we build structures of mixed nitrides for blue light emitters, which are used e.g. in Blue-ray or blue diode technologies?
- A) gallium nitride GaN
  - B) silicon carbide SiC
  - C) boron nitride BN
  - D) zinc oxide
368. What decides about specific properties of nanomaterials:
- A) large relative share of particles/atoms in the surface layer of nanocrystalite
  - B) instability of the nanocrystalite structure
  - C) passivation of nanograin surface
  - D) strong inter-grain interactions
369. Formation of one-size (1D) structures of the type coal/ nitride/ carbide/various metal or silicon nanotubes/nanowires is catalyzed by:
- A) metals, like e.g. iron Fe, cobalt Co, or nickel Ni
  - B) typical oxide impurities in substrates
  - C) trace amounts of oxygen in reaction gases [nitriding or constituting inert gas atmosphere]
  - D) free radicals
370. The VLS mechanism of creating one-dimension carbon and non-organic nanostructures is based on significant participation of precursors' reaction in:
- A) solid, liquid and gaseous phase
  - B) solid and liquid phase
  - C) liquid phase
  - D) specified temperature and pressure conditions and an appropriate type of gaseous atmosphere
371. The process of carbothermal reduction/ nitriding of obtaining metal nitrides uses:
- A) a mixture of coal or its compound and a nitriding factor
  - B) atmosphere of pure ammonia in equilibrium with hydrogen and nitrogen
  - C) a mixture of hydrogen and nitrogen
  - D) a mixture of hydrogen and ammonia

372. What does not favour the formation of pure metal nitrides from oxide precursors [ change of strong M – O bond into M – N, M = metal ]:

- A) the presence of equilibrium amounts of the forming water vapour
- B) the presence of coal in the system, because of its reduction properties
- C) the presence of hydrogen of strong affinity for oxygen
- D) reactions occurring in a flow reactor with the displacement of gaseous products

373. The outstanding achievement of Polish science, consisting in the first ever successful attempt at harnessing the technology for the creation of single GaN crystals for modern optoelectronics , took place :

- A) in the PAN Institute of High Pressures in Warsaw
- B) in the Experimental Physics Institute at the Physics Faculty of Warsaw University
- C) at the Chemistry Faculty of Warsaw Polytechnics
- D) at the Faculty of Electrical Engineering, Automatics, Computer Science and Electronics of the AGH University of Science and Technology in Krakow

374. Amonothermal synthesis of single GaN crystals according to the latest f-my AMMONO method from Warsaw, follows the reaction of:

- A) recrystallization of powdered GaN in the temperature gradient conditions in supercritical ammonia, in the presence of basic mineralizer addition
- B) metallic gallium with nitrogen at high pressure and high temperatures
- C) metallic gallium with ammonia in gaseous phase
- D) ammonolysis/deamination of gallium amide in gaseous phase

375. The structure of one-wall carbon nanotubes consists of:

- A) folded surface of one-layer graphite of  $sp^2$  [graphen's] hybridization
- B) folded surface of coal atom tetrahedrons – typical structural elements of regular coal grade, like diamond [ $sp^3$ ] hybridization
- C) folded surface obtained from the transformation of a 3D C60 fullerene [ incomplete hybridization  $sp^2$  with the participation of  $sp^3$ ]
- D) amorphous structural fragments, similar to the ones present in carbon black

376. What are biomorphous ceramic materials:

- A) coal-inorganic or inorganic materials , obtained using templates of biological origin [wood, shells etc. ]
- B) pure coal materials , obtained through pyrolysis of materials of biological origin
- C) inorganic materials in composite arrangement with organic materials of biological origin
- D) inorganic materials used in organ transplantations

377. Two-dimensional nanomaterial consists of particles that have:

- A) two dimensions on the micro-scale and one dimension on the nano-scale
- B) two dimensions on the nano-scale and one dimension on the microscale
- C) two identical dimensions on the micro-scale
- D) two identical dimensions on the nano-scale

378. An example of one-dimensional material is:

- A) nanotubes and nanowires
- B) quantum dots
- C) nano-metre- thin layers
- D) none of the above mentioned

379. III-V materials are compounds :
- A) of elements from the third and fifth group of periodic table [ according to the former group demarcation ]
  - B) containing metal on the +III oxidation level and nonmetal on the +V oxidation level
  - C) containing three to five atoms of different kind
  - D) of atoms contained between the third and the fifth group of periodic table
380. Which of metallic nitrides is characterized by very high hardness, very good electrical conductivity and gold colour?
- A) titanium nitride ( TiN)
  - B) indium nitride (InN)
  - C) silicon nitride (Si<sup>3</sup>N<sup>4</sup>)
  - D) aluminum nitride (Al N)
381. What is the structure of graphite's basic unit cell:
- A) hexagonal
  - B) rhombohedral
  - C) regular
  - D) tetragonal
382. Which parameter does not describe graphite crystallite parameters:
- A)  $L_d$  - the width of the crystallite
  - B)  $L_a$  - the diameter of the crystallite
  - C)  $d_{002}$  - interlayer distance
  - D)  $L_c$  - the height of the crystallite
383. Graphite melts :
- A) does not melt at all
  - B) at 4100 °C
  - C) at 4500 °C
  - D) at 3800 °C
384. Apparent density of expanded graphite is in the range of:
- A) 0.5 - 2 kg/m<sup>3</sup>
  - B) 4 - 5 kg/m<sup>3</sup>
  - C) 5 - 8 kg/m<sup>3</sup>
  - D) 8 - 10 kg/m<sup>3</sup>
385. Thermal conductivity of diamond is:
- A) 2000 W/m.K
  - B) 20 W/m.K
  - C) 48 W/m.K
  - D) 125 W/m.K
386. Which of the following are not carbon nanostructures:
- A) graalians
  - B) nanotubes
  - C) graphenes
  - D) fullerenes
387. The smallest possible fullerene is:
- A) C<sub>32</sub>

- B) C<sub>60</sub>
- C) C<sub>24</sub>
- D) C<sub>44</sub>

388. Which is the lattice system of fullerenes:

- A) fullerite
- B) fulgurite
- C) fullite
- D) fulcryft

389. A spinneret is:

- A) a hole for profiling fibre
- B) a set for stretching fibre
- C) a device for splicing fibre
- D) a device for winding fibre

390. Which of the following is not a structural variation of liquid crystals:

- A) peritectic variation
- B) smectic variation
- C) nematic variation
- D) cholesterin variation

391. Which of the mentioned below is not a flow machine:

- A) piston displacement compressor
- B) centrifugal compressor
- C) radial fan
- D) jet pump

392. Basic laws of flow include:

- A) all the laws mentioned below
- B) continuity equation
- C) the law of conservation of angular momentum
- D) energy equation

393. The efficiency of gas compression or expansion is determined in relation to :

- A) isentropic process
- B) isothermic process
- C) adiabatic process
- D) isobaric process

394. Which is the basic equation describing the operation of turbomachines?

- A) Euler's turbomachinery equation
- B) Bernoulli's principle
- C) otherwise Newton's Law
- D) continuity equation

395. The components [C- absolute velocity, W- relative velocity, U- the velocity of transportation] and velocity triangles at the inlet [ cross-section1 ] and at the outlet [cross-section2 ] of the radial machine rotor fulfill the equation

- A)  $W_1 + U_1 = C_1$ ,  $W_2 + U_2 = C_2$ , where for the pump :  $W_1 > W_2$ ,  $C_1 < C_2$  and  $U_1 < U_2$
- B)  $W_1 - U_1 = C_1$ ,  $W_2 - U_2 = C_2$ , where for the pump:  $W_1 < W_2$ ,  $C_1 < C_2$  and  $U_1 < U_2$
- C)  $W_1 + C_1 = U_1$ ,  $W_2 + C_2 = U_2$ , where for the pump:  $W_1 < W_2$ ,  $C_1 < C_2$  and  $U_1 = U_2$
- D)  $W_1 = C_1$ ,  $W_2 = C_2$ , where for the pump:  $U_1 > U_2$

396. Impeller pump characteristic is unequivocally defined by:
- dependence of the head on the capacity  $H[Q]$
  - rotary speed  $n$  [rev/min] and the pump power  $N[\text{kW}]$
  - volumetric capacity  $Q$  [ $\text{m}^3/\text{h}$ ] and the head  $H$  [m  $\text{H}_2\text{O}$ ]
  - geometric dimensions [rotor diameter  $D$ ] and pump weight
397. With the change of the rotor speed from  $n_0$  to  $n_1$ , basic parameters of the pump or fan work [capacity  $Q$ , pressure increase  $\Delta p$  and power  $N$ ] change in the following way:
- $Q_1 = Q_0 \cdot [n_1/n_0]$ ,  $\Delta p_1 = \Delta p_0 \cdot [n_1/n_0]^2$ ,  $N_1 = N_0 \cdot [n_1/n_0]^3$
  - $Q_1 = Q_0 \cdot [n_1/n_0]^3$ ,  $\Delta p_1 = \Delta p_0 \cdot [n_1/n_0]^2$ ,  $N_1 = N_0 \cdot [n_1/n_0]$
  - $Q_1 = Q_0 \cdot [n_1/n_0]^2$ ,  $\Delta p_1 = \Delta p_0 \cdot [n_1/n_0]$ ,  $N_1 = N_0 \cdot [n_1/n_0]^3$
  - $Q_1 = Q_0 \cdot [n_1/n_0]$ ,  $\Delta p_1 = \Delta p_0 \cdot [n_1/n_0]^3$ ,  $N_1 = N_0 \cdot [n_1/n_0]^2$
398. The flow through rotor channels and nozzle rings in the turbine is characterized by:
- velocity increase [ $\Delta W > 0$ ] and pressure decrease [ $\Delta p < 0$ ] in the direction of the fluid flow
  - increase in pressure [ $\Delta p > 0$ ] and velocity [ $\Delta W > 0$ ] in the direction of the fluid flow
  - decrease in velocity [ $\Delta W < 0$ ] and pressure [ $\Delta p < 0$ ] in the direction of the fluid flow
  - the same decrease in pressure [ $\Delta p < 0$ ] in the rotor and in the nozzles of the turbine
399. It can be assumed that in an axial machine, unlike in a radial one:
- the relative velocity between the rotor inlet [1] and discharge [2] decreases:  $W_1 = W_2$
  - the relative velocity between the rotor inlet [1] and discharge [2] is constant:  $W_1 = W_2$
  - the relative velocity between the rotor inlet [1] and the rotor discharge [2] increases  $W_1 = W_2$
  - the relative velocity between the rotor inlet [1] and rotor discharge [2] is constant:  $C_1 = C_2$
400. When several pumps are connected in series:
- the capacity of the system ( $Q$ ) remains constant, but the head ( $H$ ) increases
  - the head ( $H$ ) remains constant, but the capacity of the system ( $Q$ ) increases
  - The capacity of the system ( $Q$ ) and the head remain constant
  - The capacity of the system ( $Q$ ) decreases, but the head does not change
401. When several pumps are connected in parallel it can be assumed that:
- the head ( $H$ ) remains constant, but the capacity of the system ( $Q$ ) increases
  - the capacity of the system ( $Q$ ) remains constant, but the head ( $H$ ) increases
  - the capacity of the system ( $Q$ ) increase, but the head ( $H$ ) decreases
  - the capacity of the system ( $Q$ ) and the head remain the same
402. The basic similarity criteria for rotating machinery (rotor machines) include:
- the dimensionless specific speed:  $n_s = n \cdot Q^{1/2} [\text{gH}]^{3/4}$  and the energy expenditure indicator  $\varphi = C_x/U$
  - the Reynolds number:  $Re = w \cdot D/\nu$  and the dimensions referenced to the rotor's diameter:  $b/d$ ,  $I/D$ , etc.
  - the Reynolds number:  $Re = w \cdot D/\nu$  as well as the Nusselt number:  $Nu = \alpha D/\lambda$  and the Prandtl number  $Pr = \mu c_p/\lambda$
  - the adiabatic exponent  $k = c_p/c_v$  and the Mach number  $Ma = w/[kRT]^{1/2}$

403. Determining the operating conditions for a pump and the installation requires:
- determining the quantities measured at point A and point B
  - knowing only the pump curve:  $H[Q] = A + B \cdot Q^2$
  - calculating hydraulic losses in the installation:  $\Delta p_f = f[Q^2]$
  - calculating the rotational speed  $n$ , power  $N$  and nominal hydraulic capacity of the pump  $Q$
404. The extent of rotational reaction of a fluid-flow machine is determined by:
- an increase in stagnation enthalpy in the machine's rotor  $[\Delta h_{0r}]$  related to the respective change in enthalpy in the stage  $[\Delta h_{st}]$ :  $\Delta h_{0r} / \Delta h_{st}$
  - a decrease or an increase in the pressure  $[p_{st}]$  in a single stage of the machine
  - a change in the temperature  $\Delta T_r$  and pressure in the rotor  $\Delta p_r$  referenced to the respective change in the stage  $\Delta W_r / \Delta W_{st}$
  - an increase in the speed of the rotor  $[\Delta W_r]$  in relation to the increase in the stage:  $\Delta W_r / \Delta W_{st}$
405. The term 'confusor [K]' and 'diffuser [D]' refers to the shape of:
- the ventilator's rotor [D] and the spiral collector [D]
  - the ventilator's rotor [K] and the spiral collector [D]
  - the ventilator's rotor [K] and the spiral collector [K]
  - the ventilator's rotor [D] and the spiral collector [K]
406. STEL ( Polish: NDSC<sub>h</sub>) is:
- the maximum permissible short-term concentration occurring in the air at the work station for the period of 30 minutes [2x max 15 minutes with a minimal break of 1 hour per shift]
  - the maximum permissible short-term concentration – 2 x 1 hour per day
  - the maximum permissible short-term chemical concentration – the weighted average of chemical substances concentrations [vaporous or gaseous] per shift with no negative health impact
  - the maximum permissible short-term concentration – the maximum, but occurring at the work station for 60 minutes [2x30 minutes with a minimal break of 0.5 hours per shift]
407. TLV-C (Polish: NDSP) is:
- the maximum permissible threshold concentration – the maximum concentration which may occur at a work station and which must not be exceeded at any time
  - the maximum permissible short-term concentration – 2x 1 hour per day
  - the maximum permissible short-term chemical concentration – the weighted average of chemical substances concentrations [vaporous or gaseous] per shift with no negative health impact
  - the highest permissible threshold concentration – the highest concentration which may occur at a work station and which may be exceeded only temporarily
408. A chemical hazard is:
- a hazard related to materials and installations which causes fires, explosions, toxic contaminations and corrosivity
  - a hazard related to incompetent use of chemical substances
  - a hazard related to terrorist activity

D) a hazard related to inhaling chemical substances vapours

409. The notion of safety means:

- A) a state of confidence in undertaken proceedings which does not lead to hazards or waste
- B) proper operation of the relevant MSW services
- C) proper work station organization
- D) a state of confidence in undertaken proceedings assuming a certain degree of risk

410. A risk is:

- A) *the probability of occurrence* of one or a combination of events leading to a *dangerous* situation and negative impacts for human life or health, the natural environment and operating resources, and the frequency of such events [ $R = P \cdot F$ ]. P – probability, F – frequency
- B) the possibility of an accident in the workplace
- C) the possibility of a threat event occurrence
- D) the probability of harmful agent occurrence

411. A disaster is a result of the following sequence of events

- A) initiating event -> peak event -> risk -> disaster
- B) risk -> peak event -> initiating event -> disaster
- C) risk -> initiating event -> peak event -> disaster
- D) risk -> initiating event -> failure -> disaster

412. For a more precise characterization of hazardous substances alphanumeric symbols S and R are used. They denote:

- A) the procedure and hazards arising from its properties
- B) the way of transportation and precautions used during handling
- C) the procedure applied during handling
- D) the procedure applied in the event of uncontrolled leaks to the natural environment

413. A Safety Data Sheet for a hazardous substance includes:

- A) the manufacturing procedures of a substance
- B) the identity of the producer of a substance and their the contact details
- C) the first aid rules
- D) the handling and storage rules for a substance

414. The Quality Book in a chemical laboratory does not specify:

- A) financing rules and mutual financial settlement requirements for contactors
- B) the quality system functioning in a laboratory
- C) the manner of documenting the quality system
- D) the laboratory norms and procedures

415. The counting sheet is used for:

- A) gathering primary data for quality control steering
- B) monitoring actions at the working point
- C) analyzing the manufacturing process for the purposes of managing financial settlements
- D) describing the relationship between different working points

416. A histogram is:
- A) a bar graph representing the frequency distribution
  - B) a bar graph representing the standard deviation distribution
  - C) a bar graph representing the median
  - D) a pie chart representing the distribution of statistical data of a controlled process
417. The Pareto principle says that:
- A) 80% of the errors come from 20% of the causes
  - B) one cause can lead to several related errors
  - C) each error has its cause
  - D) 20% of the errors come from 80% of the causes
418. Accreditation of a measurement laboratory is:
- A) recognition by the Accreditation (or Licensing) Body of the laboratory's competence to conduct specific activities
  - B) recognition by a superior unit of the laboratory's competence to conduct specific activities
  - C) recognition by the relevant ministerial Council of the laboratory's competence to conduct specific activities
  - D) the permit for conducting business activity by a superior unit
419. A PCA (Polish Centre for Accreditation) auditor is:
- A) a freelance specialist auditing a company at the request of an accrediting authority
  - B) a person performing an advisory role at the workplace
  - C) a person auditing the company at the request of the Management Board
  - D) a person authorized to audit companies, employed by the Management Board of the audited company
420. According to the optimal use of potential difference principle, each stage of a process should be conducted:
- A) at a state which is the furthest from the equilibrium state
  - B) at a state close to the equilibrium state
  - C) at an increased temperature and high pressure
  - D) the answers "at a state close to the equilibrium state" and "at an increased temperature and high pressure" are both correct
421. According to the optimal use of resources principle, we should:
- A) all the answers are correct
  - B) use the required excess of reagents in relation to the stoichiometry
  - C) maximally reduce side reactions [appropriate catalyzer, reactor, process parameters]
  - D) recycle non- or incompletely reacted substrates and rationally use by-products and waste products
422. A production installation is:
- A) an assembly of equipment and instruments [usually located at a separate lot] intended to conduct a technological process in accordance with a particular technical concept

- B) an assembly of basic manufacturing equipment and instruments intended to conduct a technological process which interact with one another according to a particular plan
- C) an organized group of activities called unit operations or unit processes as a result of which a given raw material is transformed into a desired product
- D) all the answers are correct

423. In the production process of nitric acid [V], the expected product of ammonia oxidation is:

- A) NO
- B) N<sub>2</sub>
- C) N<sub>2</sub>O
- D) NO<sub>2</sub>

424. The dual-pressure nitric acid manufacturing process means that:

- A) the oxidation process and the adsorption process take place at different pressures
- B) the adsorption process takes place in two columns at different pressures
- C) the oxidation process takes place in two reactors at different pressures
- D) the installation is suitable for operating at two different pressures depending on the expected output from the manufacturing process

425. The CO-shift process is:

- A) steam conversion of carbon monoxide to hydrogen and carbon dioxide
- B) obtaining carbon monoxide from methane
- C) afterburning of carbon monoxide to carbon dioxide
- D) none of the answers is correct

426. The ammonia synthesis process:

- A) entails a decrease in the volume, so it is advisable to conduct the process at an increased pressure
- B) is catalyzed by Cu-ZnO-Al<sub>2</sub>O<sub>3</sub>
- C) is an endothermic reaction and therefore it is conducted at a high temperature
- D) the correct answers are: [entails a decrease in the volume, so it is advisable to conduct the process at an increased pressure] and [is an endothermic reaction and therefore it is conducted at a high temperature]

427. According to the classification of gaseous fuels which is applied in Poland, the classification parameters are:

- A) the gross heating value, the main constituents content or the Wobbe index
- B) the gross heating value, the net calorific value or the Wobbe index
- C) the gross heating value, the Wobbe index or the pressure before the customers' appliances using gaseous fuels
- D) the gross heating value, the Wobbe index or the major contaminants content

428. According to the classification of gaseous fuels which is applied in Poland, the family of gaseous fuels refers to:

- A) gaseous fuels being of similar origin and containing the same flammable components
- B) gaseous fuels containing the same flammable components

- C) gaseous fuels characterized by a classification parameter value falling within a fixed range
- D) gaseous fuels being of similar origin and characterized by a classification parameter value falling within a fixed range

429. According to the Polish norms, the classification of gaseous fuels into subgroups refers to:

- A) low-methane natural gases, and its criterion is the upper Wobbe index
- B) all gaseous fuels, and its criterion is the lower Wobbe index
- C) low-methane natural gases, and its criterion is the lower Wobbe index
- D) all natural gases, and its criterion is the upper Wobbe index

430. For biofuels, the maximum permissible sulphur content according to the Polish norms:

- A) is determined by the user of a gaseous fuel
- B) is determined by specifying only the maximum permissible content of hydrogen sulphide
- C) is determined by specifying only the total sulphur content
- D) is determined by specifying both the total sulphur content and the hydrogen sulphide content

431. High calorific gases manufactured by means of industrial methods include:

- A) methane-rich refinery gases
- B) coal gas and methane-rich refinery gases
- C) firedamp and methane-rich refinery gases
- D) producer gas generated from coal and gases obtained by means of industrial methods

432. For natural gas supplied to communal customers and households via the gas distribution network, the maximum permissible sulphur content according to the Polish norms:

- A) is defined by specifying the total sulphur content, mercaptan sulphur content and hydrogen sulphide content
- B) is defined by specifying the total sulphur content and hydrogen sulphide content
- C) is defined by specifying the total sulphur content
- D) is determined by consumers of a gaseous fuel

433. For natural gas supplied to communal customers and households via the gas distribution network, the maximum permissible moisture content according to the Polish norms:

- A) is not defined
- B) is defined by means of the dew point at a pressure of 5.5 MPa separately for the periods from 1 April to 30 September and from 1 October to 31 March
- C) is defined by means of the dew point at a pressure of 101.325 kPa separately for the periods from 1 April to 30 September and from 1 October to 31 March
- D) is defined by means of the dew point at a pressure of 5.5 MPa for the period 1 October to 31 March and for the period from 1 April to 30 September is not defined

434. For natural gas distributed via high-pressure natural gas network, the maximum permissible moisture content according to the Polish norms:

- A) is defined by means of the dew point at a pressure of 5.5 MPa separately for the periods from 1 April to 30 September and from 1 October to 31 March
- B) is not defined
- C) is defined by means of the dew point at a pressure of 101.325 kPa separately for the periods from 1 April to 30 September and from 1 October to 31 March
- D) is defined by means of the dew point at a pressure of 5.5 MPa for the period 1 October to 31 March and for the period from 1 April to 30 September is not defined

435. The Wobbe index (number) is connected with the following combustion performance criteria:

- A) heat load stability and the amount of primary air sucked in by injection gas burners
- B) heat load stability
- C) heat load stability and the stability of the flame on the burner
- D) heat load stability, combustion hygiene and the amount of primary air sucked in by injection gas burners

436. According to the Polish norms, the reference conditions for the gaseous fuels combustion process are:

- A) the temperature and pressure of the substrates and combustion products
- B) the temperature and pressure assumed for the purposes of determining the fuel volume which is used as a reference for the declared gross heating value or the net heating value of a gas
- C) the flame temperature of a gaseous fuel and the pressure at which the process takes place
- D) the temperature and pressure of the combustion products

437. Sulphur foam as a product of the desulphurization of gaseous fuels is obtained:

- A) only in oxidation methods
- B) in all desulphurization processes
- C) in all dry methods
- D) in oxidation methods and in the Rectisol process

438. In the process of gaseous fuels desulphurization using activated carbon, the used adsorbent regeneration is conducted by:

- A) the elution of sulphur from the activated carbon surface with ammonium sulphite
- B) oxidizing roasting of the used adsorbent
- C) adsorbent roasting in anaerobic conditions
- D) stripping sulphur from the activated carbon surface with superheated steam

439. The oxidation methods utilizing oxidants stronger than oxygen in atmospheric air for the purposes of regenerating the spent cleaning solution include:

- A) the Stretford and Takahax methods
- B) the Stretford and Perox methods
- C) the Vetrocoke and Stretford methods
- D) the Takahax and Perox methods

440. The adsorption methods for gaseous fuels desulphurization include:
- A) desulphurization processes over bog iron and activated carbon
  - B) all dry methods and the Rectisol process
  - C) desulphurization over activated carbon and the Perox process
  - D) desulphurization processes over bog iron and preliminary separation
441. Gaseous fuels desulphurization with the Rectisol process is conducted by:
- A) adsorption removal of hydrogen sulphide, hydrogen cyanide, organic compounds of sulphur, carbon dioxide, moisture and higher hydrocarbons from a gas, using methanol at a temperature of approx.  $-70^{\circ}\text{C}$  and at a pressure above 1MPa
  - B) adsorption removal only of hydrogen sulphide from a gas, using methanol at a temperature of approx.  $-70^{\circ}\text{C}$  and at a pressure above 1MPa
  - C) adsorption removal of hydrogen sulphide, hydrogen cyanide, organic compounds of sulphur, carbon dioxide, moisture and higher hydrocarbons from a gas, using ethanol at a temperature of approx.  $-70^{\circ}\text{C}$  and at a pressure above 1MPa
  - D) adsorption removal of hydrogen sulphide, hydrogen cyanide, organic compounds of sulphur, carbon dioxide, moisture and higher hydrocarbons from a gas, using methanol at a temperature of approx.  $-70^{\circ}\text{C}$  and at a pressure below 1MPa
442. The Claus process can be used in conjunction with:
- A) all adsorption methods of gaseous fuels desulphurization
  - B) all methods of gaseous fuels desulphurization
  - C) all wet methods of gaseous fuels desulphurization
  - D) adsorption methods of gaseous fuels desulphurization relying only on the phenomenon of chemical adsorption
443. In the case of natural gas desiccation for the purposes of its pipeline transport under high pressure, the following methods are commonly used:
- A) ethylene glycol absorption methods, since they ensure sufficient gas desiccation
  - B) adsorption methods
  - C) methods involving gas cooling
  - D) ethylene glycol absorption methods, since they ensure the highest level of gas desiccation
444. In the process of preparing natural gas for its pipeline transport, natural gasoline is separated from natural gas:
- A) in the processes of: preliminary separation and natural gas degasolination
  - B) mostly in the process of natural gasoline stabilisation
  - C) exclusively in the process of natural gas degasolination
  - D) in the processes of: preliminary separation, natural gas degasolination and natural gasoline stabilisation
445. Absorption methods of separating natural gasoline from natural gas involve:
- A) natural gasoline removal from natural gas by means of its absorption in wash oil, and next its desorption in steamed oil at a temperature of  $150\text{-}160^{\circ}\text{C}$

- B) stabilized gasoline removal from natural gas by means of its absorption in wash oil, and next its desorption in steamed oil at a temperature of 150-160 °C
  - C) natural gasoline removal from natural gas by means of its absorption in wash oil, and next its desorption from used oil with steam at a temperature of 100-110 °C
  - D) natural gasoline removal from natural gas by means of its absorption in methanol, and next its desorption methanol with steam at a temperature of 150-160 °C
446. For compressing natural gas in gas compressor stations, we use the following:
- A) reciprocating and rotary compressors mostly driven by compression-ignition engines and gas turbines
  - B) reciprocating and rotary compressors mostly driven by electric motors and gas turbines
  - C) centrifugal compressors and Root compressors mostly driven by electric motors and gas turbines
  - D) reciprocating and rotary compressors mostly driven by spark-ignition gas engines and gas turbines
447. The distances between gas compressor stations in a gas trunkline (main gas line) are:
- A) 80-200 km
  - B) 5-10 km
  - C) 30-60 km
  - D) more than 500 km
448. In a high-pressure pipeline, the average pressure:
- A) is higher than the arithmetic mean of the initial pressure and the final pressure
  - B) is equal to the arithmetic mean of the initial pressure and the final pressure
  - C) is equal to the geometric mean of the initial pressure and the final pressure
  - D) is lower than the arithmetic mean of the initial pressure and the final pressure
449. Liquified natural gas transport:
- A) may be less or more expensive than natural gas transport through pipelines, depending on the distance
  - B) is more expensive than natural gas transport through pipelines
  - C) is less expensive than natural gas transport through pipelines
  - D) with regard to costs is comparable to natural gas transport through pipelines
450. The maximum useful capacities of underground gas reservoirs are of the order of
- A) billions m<sup>3</sup>
  - B) millions m<sup>3</sup>
  - C) less than 1 million m<sup>3</sup>
  - D) less than 10 million m<sup>3</sup>
451. Underground gas reservoirs in salt caverns are used to:
- A) guarantee proper conditions for the optimal exploitation of a gas transport system as well as to ensure the continuity of gas supply and off-take from the system during repair and maintenance works of particular elements of the system
  - B) ensure energy security of the country
  - C) ensure the continuity of imported gas supply
  - D) ensure the continuity of gas supply for industrial gas customers

452. The role of gas stations is to:
- A) measure the amount of gas and reduce its pressure to lower levels
  - B) increase gas pressure prior to its further transmission
  - C) prepare gas for its transmission via a gas trunkline (main gas line)
  - D) refuel vehicles powered by CNG [Compressed Natural Gas]
453. The two-stage natural distribution system is characterized by the fact that:
- A) it combines pipelines at two different pressure levels
  - B) it combines pipelines of two different diameters
  - C) gas is supplied to customers' installations from a medium-pressure pipeline via a domestic gas reducer
  - D) gas is supplied to both households and industrial customers
454. Ring distribution networks are used :
- A) in the case of expanding the gas supply system in a densely built up area
  - B) in the case of expanding the gas supply system in rural areas with scattered housing
  - C) in the case of expanding the gas supply system in non-industrialised regions
  - D) in cities with a population above 1 million inhabitants
455. The boundary pressure value distinguishing low and medium pressure networks is:
- A) 10 kPa
  - B) 0.4 kPa
  - C) 1 kPa
  - D) 1 Mpa
456. The commercial diameter of the pipe is specified by:
- A) the pipe diameter selected from the manufacturer's catalogue
  - B) the effective pipe diameter, i.e., taking into account its dimension tolerances
  - C) the outside pipe diameter
  - D) the inside pipe diameter plus the doubled thickness of the wall
457. The term "distribution pressure drop" refers to:
- A) a difference between the design maximum pressure and the design minimum pressure in the network
  - B) a pressure drop in a network section of the unit length
  - C) a pressure drop during the flow of gas through a pipe of the unit diameter
  - D) a difference between the main supplying point and the first branching in the network
458. The simultaneity factor for gas delivery:
- A) expresses the ratio of the actual gas delivery to the amount of gas resulting from the efficiency of the installed appliances
  - B) is an indicator describing the gas-flow uniformity of in particular rings of the distribution network per day
  - C) is an indicator describing the gas-flow uniformity in particular rings of the distribution network per year
  - D) denotes the number of consumers receiving gas from the distribution network at the same time

459. The calculated gas stream for municipal use and household purposes [meals preparation and domestic hot water] is:
- A) larger than the space heating demand
  - B) lower than the space heating demand
  - C) the same as the space heating demand
  - D) constant and independent of the degree of urbanization
460. The border between the gas distribution network and the gas installation is:
- A) the master valve
  - B) the gas meter at the customer's house
  - C) the home reducer
  - D) a separate line that branches off to supply gas to a household from the main network
461. The flame stability on the gas burner depends on:
- A) the flame velocity and the linear velocity of the flow rate of gas through the outflow nozzle
  - B) the calorific value of the gas and the quantity of air sucked in through the injector
  - C) the relative density of gas and the overpressure of the gas before the gas burner [relative to the pressure of the environment]
  - D) the heat load of the gas appliance and its efficiency
462. Which of the items below is not included in a gas installation:
- A) a household gas reducer
  - B) a gas meter
  - C) a gas cooker with an oven
  - D) a waste gas duct that carries away flue gases from a bathroom heater
463. The gas compressibility factor is used:
- A) as an adjustment approximating a gas behaviour to an ideal gas behavior
  - B) to characterise the ability of a gas to reduce the gas pressure in reducers
  - C) to characterize gas behavior in the compression process
  - D) to specify changes in gas composition at gas stations
464. The flammable properties of a gas include:
- A) the flammability limits, the flash point, the autoignition temperature and the normal combustion rate of the gas
  - B) the gross calorific value and the net calorific value of the gas as well as the theoretical demand for air necessary for combustion to take place
  - C) the gross calorific value, the net calorific value and the normal combustion rate of the gas
  - D) the gross calorific value, the net calorific value and the relative density of the gas
465. Favourable conditions for the formation of methane hydrates in natural gas transmission pipelines are:
- A) low temperature, high pressure, high moisture content and high hydrogen sulphide content in a gas
  - B) low temperature, low pressure, high moisture content and low hydrogen sulphide content in a gas

- C) low temperature, high pressure, high moisture content and low hydrogen sulphide content in a gas
  - D) low temperature, low, high moisture content and high hydrogen sulphide content in a gas
466. The spontaneous ignition temperature of a fuel gas-air mixture is:
- A) the lowest temperature of this mixture at which its spontaneous ignition can take place
  - B) the lowest temperature of an external source of ignition
  - C) the lowest temperature of the container walls at which the mixture will ignite
  - D) lower than the forced ignition temperature
467. Heat of combustion is the amount of heat released during:
- A) complete and perfect combustion involving a release of water in the liquid form
  - B) complete combustion involving a release of water vapour
  - C) perfect combustion involving a release of water in the liquid form
  - D) complete and perfect combustion involving a release of water vapour
468. The net calorific value of a fuel is determined on the basis of:
- A) subtracting the vapourisation heat of water contained in the flue gas/exhaust gas from the heat of combustion
  - B) adding the vapourisation heat of water contained in the flue gas/exhaust gas to the heat of combustion
  - C) adding the formation heat of nitric and sulphuric acids in the flue gas/exhaust gas to the heat of combustion
  - D) subtracting the formation heat of nitric and sulphuric acids in the flue gas/exhaust gas from the heat of combustion
469. For the complete combustion of 1 m<sup>3</sup> of methane, it is necessary to supply at least:
- A) 9.5 m<sup>3</sup> of air
  - B) 4 m<sup>3</sup> of air
  - C) 6.5 m<sup>3</sup> of air
  - D) 12 m<sup>3</sup> of air
470. The combustion of 1 kg of clean coal at the air surplus coefficient equal to 2, it is necessary to supply:
- A) 5.3 kg of oxygen
  - B) 2.7 kg of oxygen
  - C) 4.4 kg of oxygen
  - D) 8.5 kg of oxygen
471. The combustion of 2 m<sup>3</sup> of ethane releases:
- A) 4 m<sup>3</sup> of CO<sub>2</sub>
  - B) 1 m<sup>3</sup> of CO<sub>2</sub>
  - C) 2 m<sup>3</sup> of CO<sub>2</sub>
  - D) 6 m<sup>3</sup> of CO<sub>2</sub>
472. The calorimetric combustion temperature refers to:
- A) stoichiometric combustion not taking into account the exhaust gas dissociation
  - B) surplus air combustion

- C) stoichiometric combustion taking into account the exhaust gas dissociation
- D) surplus air combustion taking into account the heating of air and fuel

473. The theoretical combustion temperature takes into account:

- A) the heating of air and fuel as well as the exhaust gas dissociation during surplus air combustion
- B) heat loss to the environment during surplus air combustion
- C) heat loss to the environment and the exhaust gas dissociation
- D) all of the above

474. An increase in the combustion temperature can be achieved by:

- A) all the answers are correct
- B) increasing the amount of oxygen in the air used for combustion
- C) heating the air used for combustion
- D) decreasing the amount of the surplus air

475. A decrease in the coefficient value of surplus air flow will cause:

- A) an increase in the combustion temperature
- B) a decrease in the combustion temperature
- C) does not have any effect on the combustion temperature
- D) for gaseous fuels: an increase in the combustion temperature, while for solid fuels: a decrease in the combustion temperature

476. Controlling the combustion process with the Ostwald triangle enables to:

- A) determine the CO<sub>2</sub> concentration in the exhaust gases and the coefficient of surplus air flow
- B) determine the amount of the air for combustion and the composition of the exhaust gases
- C) determine the calorimetric combustion temperature and the exhaust gas dissociation
- D) determine the composition of the exhaust gases

477. Acid rains are caused by:

- A) sulphur oxides
- B) nitrogen oxides
- C) carbon dioxide
- D) carbon monoxide

478. A decrease in carbon dioxide emissions when burning coal can be achieved by:

- A) increasing energy generation efficiency
- B) co-firing of biomass
- C) replacing coal with natural gas
- D) replacing hard coal with lignite

479. The proper assembly of machinery and equipment with regard to obtaining an increasing reduction ratio is:

- A) a jaw crusher, a tumbling mill, an air jet mill
- B) a jaw crusher, a roll crusher, a colloid mill
- C) a jaw crusher, an air jet mill, a tumbling mill
- D) a ball-and-race-type pulverizer mill, a roll crusher, a jaw crusher

480. Conveyors are devices whose basic function is to:
- A) convey a material
  - B) convey and dispense a material
  - C) dispense a material
  - D) convey, dispense and pack a material
481. To the group of band conveyors we can include:
- A) drag, bucket and belt conveyors
  - B) pneumatic, vibrating and screw conveyors
  - C) screw, oscillating and vibrating conveyors
  - D) chute, vibrating and screw conveyors
482. The separation of suspended solids from liquids takes place in the following devices:
- A) filter presses, sedimentation tanks, centrifugal separators
  - B) filter presses, sedimentation tanks, fabric filters
  - C) fabric filters, cyclones, dust sedimentation chambers
  - D) electrostatic precipitators, absorbers, fabric filters
483. Dust particulates separation takes place in:
- A) fabric filters, settling chambers, electrostatic precipitators
  - B) cyclones, fabric filters, foam dust collectors
  - C) sedimentation tanks, fabric filters, centrifugal separators
  - D) cyclones, filter presses, centrifugal separators
484. The formation of solid crystals in industrial crystallizers may be caused by:
- A) cooling the solution or solvent evaporation
  - B) cooling the solution or heating the solution with a simultaneous decrease in the pressure
  - C) intensive mixing of the solution
  - D) mixing the solution intended for crystallization with a solvent
485. Agglomeration of particulate materials may take place through:
- A) pressure compacting small particles of a particulate material
  - B) pouring a moisturized powder material in appropriate apparatus/devices
  - C) granulation, sintering, briquetting
  - D) sieving particulate materials
486. The working principle of impeller pumps is:
- A) as a result of a centrifugal force, liquid particles are displaced towards the outside perimeter of the rotor, which causes the inlet pressure of the pump to decrease and the liquid to be sucked in
  - B) as a result of a centrifugal force, the kinetic energy and the pressure of the liquid increase, which causes the inlet pressure of the pump to decrease and the liquid to be sucked in as well as an increase in the outlet pressure of the pump
  - C) as a result of a centrifugal force, liquid particles are displaced towards the outside perimeter of the rotor, which causes the inlet pressure of the pump to decrease and the liquid to be sucked in
  - D) as a result of a gravitational force, liquid particles are displaced towards the outside perimeter of the rotor, which causes the inlet pressure of the pump to decrease and the liquid to be sucked in

487. The group of positive displacement pumps may include:

- A) piston, gear and sliding vane pumps
- B) plunger, sliding vane and gear pumps
- C) piston, propeller and screw pumps
- D) impeller, piston and gear pumps

488. Proportioning of bulk materials can be done:

- A) by volume and by weight
- B) only by weight
- C) only by volume
- D) bulk materials cannot be proportioned

489. Proportioning of gases can be done:

- A) by volume
- B) by weight
- C) by volume and by weight
- D) gases cannot be proportioned; they can only be injected

490. The capacity and the delivery head of the centrifugal (rotodynamic) pump can be increased by combining pumps into assemblies:

- A) the capacity : for pumps connected in parallel; the pump delivery head: for pumps connected in series
- B) the capacity : for pumps connected in series; the pump delivery head: for pumps connected in parallel
- C) the capacity : for pumps connected in parallel; the pump delivery head: for pumps connected in parallel
- D) the capacity: for pumps connected in series; the pump delivery head: for pumps connected in series

491. The process of the thickening of solutions in industrial conditions takes place in:

- A) evaporators, evaporator batteries
- B) sedimentation tanks, centrifuges
- C) filters, filter presses
- D) crystallisers, tank mixers

492. Which of the following unit operations can be performed in industrial conditions using counter-current flow:

- A) extraction
- B) crystallization
- C) filtration
- D) electrolysis

493. Which of the following unit operations can be performed in industrial conditions using counter-current flow:

- A) drying
- B) sedimentation
- C) centrifugation
- D) sublimation

494. One of the cooling/heating methods is the application of heat regenerators. The term "heat regenerator" may refer to:

- A) a solid absorbing and emitting thermal energy
- B) a substance that absorbs or emits heat as a result of a chemical reaction
- C) a material that absorbs or emits surplus heat as a result of a phase transition
- D) a medium that flows through a membrane heat exchanger causing cooling or heating

495. Which of the following methods can be used to separate ingredients of a uniform mix in industrial conditions:

- A) distillation and rectification
- B) distillation and absorption
- C) absorption and adsorption
- D) fluidization and pumping

496. The vaporizer is a device for:

- A) pre-concentrating solutions
- B) removing contaminants from the gas stream
- C) removing particulates from solutions
- D) steam distillation

497. The term "recuperator" may not be applied to:

- A) a membrane heat exchanger
- B) a membraneless heat exchanger
- C) a co-current extractor
- D) packed absorption column

498. The term "mass exchanger" does not apply to:

- A) a vacuum pump and a dispenser
- B) a mill and a crusher
- C) an adsorber and an absorber
- D) an extractor and a rectifying column

499. A simultaneous exchange of mass and heat may not occur in

- A) fabric filters
- B) electrostatic precipitators
- C) membrane heat exchangers
- D) membraneless heat exchangers

500. The Stirling engine is:

- A) an external combustion engine
- B) a reciprocating internal combustion engine
- C) an electric motor
- D) a pneumatic motor