

Model Questions – Biophysics, Biology, Chemistry

This set of **300** model questions is meant as preparation material for the entrance examination at the Second Faculty of Medicine, Charles University. A hundred questions from each subject (**biophysics**, **biology** and **chemistry**) showcase the topics and style of questions applicants can expect during their entrance examination. Multiple answers can be correct, ranging from only one to all four. In the entrance examination, failing to mark all correct answers is counted as a mistake and awards 0 points. **Correct** answers are **highlighted in bold** in the **last** section of this document.

Biophysics

Mechanics

- 9.81 Pa can be expressed as:**
 - 1 N
 - $9.81 \text{ kg} \cdot \text{m}^{-1} \cdot \text{s}^{-2}$
 - $9.81 \text{ N} \cdot \text{m}^2$
 - 9.81 N m^{-2}
- A rectangular prism-shaped aquarium has a height of 75 cm; two-thirds of its volume is filled with water. The aquarium stands on a flat, solid base, and its side walls are subjected to the internal pressure of the water and the external atmospheric pressure. Then the following holds true:**
 - The pressure difference between the liquid at the bottom and the pressure on the base is zero
 - The pressure on the side wall at the bottom is 7.5 kPa
 - The pressure on the side wall just below the surface is 100 kPa
 - The pressure on the side wall at the bottom is 5000 Pa
- A car with a total weight of 1000 kg starts moving from rest on a horizontal road and reaches a velocity of 20 m/s in 10 seconds. Its engine power, disregarding losses, must have been at least:**
 - 1000 W
 - 2 kW
 - 20 kW
 - 200,000 J

4. **Within 10 minutes, we need to pump out 10 hectolitres of water from a depth of 10 metres, the efficiency of the pump is 90%. Then:**
- A power input of 150 W will be sufficient
 - the pump will consume at least 1 kWh of energy
 - The potential energy of the water will increase by 100 kJ
 - The pump flow rate will be $0.1 \text{ m}^3 \cdot \text{min}^{-1}$
5. **Bernoulli's equation for the flow of an ideal fluid in a horizontal pipe is given by (p – fluid pressure, ρ – fluid density, V – volume, v – flow velocity, m – mass):**
- $p + \rho \cdot v^2 = \text{const.}$
 - $p \cdot V + 1/2 \cdot \rho \cdot v^2 = \text{const.}$
 - $p + 1/2 \cdot \rho \cdot v^2 = \text{const.}$
 - $p + 1/2 \cdot m \cdot v^2 = \text{const.}$
6. **Bernoulli's equation expresses:**
- The law of conservation of energy of an ideal fluid
 - The law of conservation of momentum of an ideal fluid
 - The dependence of gas pressure on temperature
 - The dependence of turbulence in the fluid on velocity
7. **Two small masses, each with a mass of 50 kg, placed at a distance of 50 cm from each other, attract each other with a gravitational force of ($\kappa = 6.67 \cdot 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2$):**
- $6.67 \cdot 10^{-11} \text{ N}$
 - $6.67 \cdot 10^{-7} \text{ N}$
 - $6.67 \cdot 10^{-9} \text{ N}$
 - $3.34 \cdot 10^{-7} \text{ N}$
8. **Two containers with liquid are closed with a movable circular piston. In the first container, a force F acts on the piston with a radius r , creating a pressure p in the liquid. In the second container, the same force F acts on the piston with a radius of $2r$. The pressure in the second liquid will be:**
- $2p$
 - $4p$
 - $p/2$
 - $p/4$

9. **Two containers with liquid are closed with a movable piston. In the first container, a force F acts on the piston with an area S , creating a pressure p in the liquid. In the second container, the same force F acts on the piston with an area of $2S$. The pressure in second liquid will be p :**
- $2p$
 - $4p$
 - $p/2$
 - $p/4$
10. **Two containers with the same base area, one cylindrical and the other conically narrowing, are filled with water to the same height. Then:**
- Both containers will have the same force acting on the bottom, because the base areas of the containers and the heights of the liquid are equal
 - Both containers will have different forces acting on the bottom, because the volume of liquid in the containers differs
 - Both containers will have the same hydrostatic pressure at the bottom, because the height of the liquid in the containers is the same
 - Both containers will have different hydrostatic pressures at the bottom, because the mass of the liquid in the containers is different
11. **An action-reaction pair of forces are:**
- Any two forces of opposite direction
 - Two forces of equal magnitude and opposite direction, lying on a straight line
 - Two forces of equal magnitude and opposite direction, acting on different bodies
 - Two forces of the same direction, acting on the same body
12. **The gravitational constant has a numerical value of $6.67 \cdot 10^{-11}$ when using the SI system. From the law of gravitation, we can deduce that its unit is:**
- N
 - $\text{N} \cdot \text{kg}^2/\text{m}^2$
 - $\text{N} \cdot \text{m}^2/\text{kg}^2$
 - $\text{m}^3/(\text{s}^2 \cdot \text{kg})$
13. **The gravitational potential energy of a body of mass m at a small height h above the Earth is expressed by the relation (K – intensity of the gravitational field; assuming that $E_p = 0$ for $h = 0$):**
- $E_p = m \cdot K/h$
 - $E_p = m \cdot K \cdot h/2$
 - $E_p = m \cdot K \cdot h$
 - $E_p = m \cdot K \cdot h^2/2$

14. **The value closest to the hydrostatic pressure at a depth of 10 m below the water surface is:**

- a) 100 kPa
- b) 10,000 Pa
- c) 106 Pa
- d) 98.1 Pa

15. **Hooke's law holds:**

- a) Throughout the entire range of material deformation
- b) Even in the area of plastic (permanent) deformation
- c) Up to the limit of material strength
- d) In the area of elastic deformation of the material

Thermodynamics

16. **An ideal gas:**

- a) only absorbs heat
- b) does not perform work when expanding
- c) is incompressible
- d) is perfectly compressible and without internal friction

17. **The SI unit of energy is:**

- a) joule
- b) kilocalorie
- c) newton
- d) calorie

18. **Regarding the 2nd law of thermodynamics:**

- a) it implies that the entropy of an isolated thermodynamic system cannot increase
- b) it implies that the entropy of an isolated thermodynamic system cannot decrease
- c) living systems do not violate it, as their entropy does not decrease
- d) living systems do not violate it, as they are open systems

19. **For the work W performed by a gas at a constant pressure p , the following holds true (ΔT is the change in gas temperature, ΔV is the change in gas volume):**

- a) W is always equal to zero
- b) $W = p \cdot \Delta T$
- c) $W = p \cdot \Delta V$
- d) $W = p \cdot \Delta T \cdot \Delta V$

20. **Heat can be transmitted through:**

- a) conduction in thermally conductive materials
- b) convection in fluids
- c) radiation or emission
- d) vacuum

21. **A temperature of 0 Kelvin:**

- a) corresponds to the melting point of ice at a pressure of 101.3 kPa
- b) is the temperature at which liquid hydrogen solidifies
- c) corresponds to a temperature of 273.15 °C
- d) is a state of matter that cannot be fully achieved, at which the thermal motion of molecules would cease

22. **Internal energy is:**

- a) the sum of the total kinetic energy of the randomly moving particles of a body and the total potential energy of the mutual positions of these particles
- b) only the energy of nucleons in the atomic nucleus
- c) equal to the total potential energy of the mutual positions of particles
- d) equal to the total kinetic energy of the randomly moving particles of a body

23. **The basis of the kinetic theory of the structure of matter structure are three experimentally verified findings. Identify the statement that does not belong to this basis (and which is not true):**

- a) matter of any state consists of particles
- b) particles do not exert any forces on each other
- c) particles mutually exert attractive and repulsive forces
- d) particles move within the matter

24. **The unit of heat capacity in SI base units is:**

- a) $\text{m}^2 \cdot \text{kg} \cdot \text{K}^{-1} \cdot \text{s}^{-2}$
- b) $\text{m}^2 \cdot \text{K} \cdot \text{s}^{-2}$
- c) $\text{m}^2 \cdot \text{kg} \cdot ^\circ\text{C} \cdot \text{s}^{-2}$
- d) $\text{m}^2 \cdot \text{K}^{-1} \cdot \text{s}^{-2}$

25. **Amorphous substances are:**

- a) isotropic
- b) artificially prepared, do not occur naturally
- c) usually crystalline
- d) anisotropic

26. If we pour water into a container with a soluble solid colouring substance, the solution quickly colours just above the substance. The colouring will continue to spread upwards. This observed phenomenon is called:
- surface tension
 - internal friction
 - osmosis
 - diffusion
27. If the specific latent heat of fusion of ice at 0 °C is 334 J·g⁻¹, the specific latent heat of vaporisation (boiling) at 100 °C is 2256 J·g⁻¹, and the specific heat capacity of water (in the temperature range 0 °C to 100 °C) is approximately 4200 J·kg⁻¹·K⁻¹; then the following hold true:
- less heat is needed to heat water from 0 °C to 100 °C than to melt ice of the same mass at 0 °C
 - less heat is needed to heat water from 25 °C to 100 °C than to evaporate this amount of water at 100 °C
 - less heat is needed to melt ice of a given mass at 0 °C than to evaporate water of the same mass at 100 °C
 - the same amount of heat is needed to melt ice at 0 °C and heat water of the same mass to 40 °C as to heat water of the same mass from 0 °C to 40 °C
28. Which of the following is not correct?
- the unit of latent heat is J·K⁻¹
 - the unit of specific latent heat of fusion is J·kg⁻¹
 - the unit of heat capacity of a body is J·K⁻¹
 - the unit of specific heat capacity is J·kg⁻¹·K⁻¹
29. Let α denote the thermal coefficient of linear expansion of solid substances and β the coefficient of volumetric expansion, then approximately:
- $\beta \approx \alpha^3$
 - $\beta \approx \alpha/3$
 - $\beta \approx 3/\alpha$
 - $\beta \approx 3 \cdot \alpha$

30. **For the equilibrium distance r_0 between two atoms (for instance, in a molecule or solid substance):**
- a) the resultant force is attractive
 - b) the resultant force is repulsive
 - c) the resultant force is zero
 - d) the character of the resultant force cannot be clearly determined
31. **Why does a liquid cool down during evaporation?**
- a) the evaporating liquid takes a portion of energy from the rest of the liquid
 - b) during evaporation, a portion of the liquid's energy is used up as latent heat of vaporisation
 - c) during evaporation, a portion of the liquid's energy is used up as latent heat of fusion
 - d) during evaporation, a portion of the liquid's energy is transferred to particles to overcome the surface tension
32. **Sublimation is the transition:**
- a) from the gaseous state to the liquid state
 - b) from the gaseous state to the solid state
 - c) from the solid state to the gaseous state
 - d) from the liquid state to the gaseous state
33. **Melting is the transition:**
- a) from the solid state to the liquid state
 - b) from the liquid state to the solid state
 - c) during which the substance releases energy
 - d) from the liquid state to the gaseous state
34. **A body is floating in water. Assume that the coefficient of thermal volumetric expansion of the body is greater than the coefficient of thermal volumetric expansion of water. What will happen to the position of the body in the water if we heat both the body and the water by the same temperature difference?**
- a) the body will float higher
 - b) the body will continue to float
 - c) the body will sink to the bottom
 - d) the position of the body will not change
 - e) the substance releases energy

Acoustics

35. The decibel (dB) is a unit of:

- a) velocity of sound propagation
- b) sound intensity level
- c) pitch of a tone
- d) acoustic power

36. Mechanical waves with a frequency less than 16 Hz:

- a) are called ultrasound
- b) are called infrasound
- c) correspond to the frequency of sound waves during clearly audible speech
- d) are clearly audible to a healthy ear

37. Regarding the sound intensity level:

- a) the threshold of hearing corresponds to a level of 1 B = 10 dB
- b) the threshold of hearing corresponds to a level of 0 B = 0 dB
- c) the threshold of pain corresponds to a level of 12 B
- d) the threshold of pain corresponds to a level of 12 dB

38. Regarding the velocity of sound:

- a) the velocity of sound in air is greater than that in solid and liquid materials
- b) the velocity of sound in air is less than that in water
- c) the velocity of sound in air and that in water are equal
- d) the velocity of sound in air is independent of temperature and atmospheric pressure

39. Identify the correct statements:

- a) Mechanical waves with frequencies below 16 Hz are called infrasound.
- b) Mechanical waves with frequencies below 20 kHz are called ultrasound.
- c) Audible sound is a mechanical wave with a frequency range of approximately 16 Hz to 20 kHz.
- d) The actual frequency range of hearing in humans varies between individuals and with age

40. After a stress test, the patient's pulse-rate doubled:

- a) the period of cardiac activity was doubled
- b) the period of cardiac activity was halved
- c) the frequency of cardiac activity was doubled
- d) the frequency of cardiac activity was halved

41. **If an observer approaches a stationary source at a velocity equal to twice the velocity of sound, the observed frequency compared to the frequency emitted by the source is:**
- a) doubled
 - b) tripled
 - c) halved
 - d) one-third
42. **The velocity of sound in air is approximately:**
- a) $340 \text{ m}\cdot\text{s}^{-1}$
 - b) $3.4 \text{ km}\cdot\text{s}^{-1}$
 - c) $3400 \text{ km}\cdot\text{s}^{-1}$
 - d) $340 \text{ km}\cdot\text{h}^{-1}$
43. **Due to the Doppler shift, the frequency of received ultrasonic waves is higher when:**
- a) the detector moves towards the source
 - b) the source and the detector move away from each other
 - c) the source and the detector move in the same direction and at the same velocity
 - d) the source moves towards the detector

Optics

44. **The absolute refractive index is defined as:**
- a) the product of the velocity of light in a vacuum and in a given medium
 - b) the ratio of the velocity of light in a vacuum to that in a given medium
 - c) the ratio of the velocity of light in two arbitrary mediums, at the interface of which light refraction occurs
 - d) the ratio of the angle of refraction to the angle of incidence
45. **Glasses in which diverging lenses are used to:**
- a) move the final image of the object closer to the eye lens
 - b) move the final image of the object further from the eye lens
 - c) correct myopia (short-sightedness)
 - d) correct hyperopia (long-sightedness)

46. **The human eye is the least sensitive to light that is:**

- a) red
- b) yellow-green
- c) white
- d) black

47. **The critical angle is the angle:**

- a) of incidence, at which the angle of refraction is 0°
- b) of reflection, corresponding to an angle of incidence of 90°
- c) of incidence, at which total reflection occurs, which can happen when the beam travels from a medium with a higher light velocity to a medium with a lower light velocity
- d) of incidence, at which the angle of refraction is 90° , which can happen when the beam travels from a medium with a lower light velocity to a medium with a higher light velocity

48. **The image created by the objective lens of an optical microscope is:**

- a) real
- b) observed through the eyepiece
- c) magnified
- d) upright

49. **The optical interval of a microscope refers to:**

- a) the distance from the objective lens to the eyepiece
- b) the distance from the focal point of the eyepiece to the focal point of the objective lens
- c) the length by which the microscope's tube can be moved
- d) the length of the microscope

50. **The approximate velocity of light in a vacuum is:**

- a) $340 \text{ m} \cdot \text{s}^{-1}$
- b) $3 \cdot 10^8 \text{ km} \cdot \text{s}^{-1}$
- c) $3 \cdot 10^8 \text{ km} \cdot \text{h}^{-1}$
- d) $3 \cdot 10^8 \text{ m} \cdot \text{s}^{-1}$

51. **The resolving power of a microscope:**

- a) depends only on the intensity of illumination
- b) is defined as the distance between two points that the observer can still distinguish
- c) cannot be changed by replacing the eyepiece
- d) does not change when swapping the objective and eyepiece

52. **The velocity of light propagation in water is:**

- a) dependent on frequency
- b) greater than in air
- c) less than in a vacuum
- d) dependent on the colour of light

Electricity and Magnetism

53. **A large current flows through a diode only when the diode's anode is:**

- a) connected to the negative pole = reverse direction
- b) connected to the positive pole = forward direction
- c) connected to the positive pole = reverse direction
- d) connected to the negative pole = forward direction

54. **Electromagnetic radiation is:**

- a) longitudinal wave of vectors E and B
- b) transverse wave of vectors E and B , which are mutually perpendicular
- c) transverse wave of vectors E and B , which are mutually parallel
- d) longitudinal wave of vectors E and B , which are mutually perpendicular and phase shifted by $\pi/2$

55. **An electron in a homogeneous electric field moves:**

- a) along a circular path
- b) generally along a parabola
- c) at a constant speed
- d) in such a way that it is accelerated against the direction of the intensity of the electric field

56. **Electronvolt (eV) is a secondary unit of:**

- a) energy
- b) electric charge
- c) electric voltage
- d) momentum

57. **Electrons can participate in the conduction of electric current as free carriers of electric charge in:**

- a) electrolytes
- b) metals
- c) ionized gases
- d) semiconductors

58. The binding energy of a chemical bond:

- a) indicates the amount of energy needed to break the bond
- b) indicates the number of bonds between atoms
- c) characterizes the strength of the bond
- d) can be expressed in electron volts

59. Induced voltage:

- a) is completely independent of the change in the magnetic flux
- b) does not depend on the rate of change of the magnetic flux
- c) is higher the slower the rate of change in the magnetic flux
- d) is higher the rate of change in the magnetic flux

60. The magnitude of an alternating current circuit with inductance:

- a) is linearly dependent on the inductance of the coil and the frequency of the alternating current
- b) does not depend on the frequency of the alternating current
- c) is directly proportional to the inductance of the coil and inversely proportional to the frequency of the alternating current
- d) is quadratically proportional to the inductance of the coil and directly proportional to the frequency of the alternating current

61. If the diode is connected in the forward direction, then:

- a) it has superconductor properties
- b) its resistance is high and a large current flows through it
- c) its resistance is low and a large current flows through it
- d) its resistance is high and only a negligible current flows through it

62. If a semiconductor diode is connected in the reverse direction:

- a) the negative pole is connected to the anode and the positive pole to the cathode
- b) only a negligible current flows through it
- c) its resistance is almost zero
- d) its resistance is high

63. **The magnitude of an alternating current circuit with capacitance is:**
- a) independent of the capacitance of the capacitor and the frequency of the alternating current
 - b) inversely proportional to the capacitance of the capacitor and directly proportional to the frequency of the alternating current
 - c) directly proportional to the capacitance of the capacitor and the frequency of the alternating current
 - d) inversely proportional to the capacitance of the capacitor and the frequency of the alternating current
64. **A magnetic field is characterized by a vector quantity called:**
- a) the permeability of the medium
 - b) magnetic induction
 - c) the mass of the iron core of the coil
 - d) relative permeability
65. **The specific conductivity of electrolytes:**
- a) expresses their ability to conduct electrical current
 - b) depends on concentration
 - c) depends on temperature
 - d) is substantially lower than that of metallic conductors
66. **A charged particle is released with zero velocity in a homogeneous magnetic field; the particle:**
- a) begins to move with uniform acceleration
 - b) begins to move in a direction parallel to the field lines
 - c) begins to move in a direction perpendicular to the field lines
 - d) remains at rest
67. **A moving charged particle enters a homogeneous electric field with a vector of intensity perpendicular to the direction of motion:**
- a) the direction of the particle's motion changes, but not the magnitude of its velocity
 - b) the magnitude of the particle's velocity changes, but not the direction of its motion
 - c) the path changes to a circular one
 - d) the path changes to a parabolic one

68. **A variable magnetic field is the cause of an electric field. This phenomenon is called:**
- a) electromagnetic induction
 - b) Doppler effect
 - c) electrolysis
 - d) polarization
69. **Which of the following is NOT correct:**
- a) the unit of magnetic flux is 1 Wb
 - b) the unit of specific heat capacity is $1 \text{ J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1}$
 - c) the unit of frequency is 1 Hz
 - d) the unit of power is 1 kWh
70. **Polarization of a dielectric means:**
- a) the movement of its particles towards oppositely charged electrodes
 - b) the orientation of electric dipoles from atoms or molecules
 - c) the removal of electrons from the dielectric
 - d) the creation of an internal electric field of the dielectric
71. **For alternating current in a circuit with resistive load:**
- a) Ohm's law does not apply
 - b) Ohm's law applies
 - c) Ohm's law applies, but only for small currents ($I < 1 \text{ mA}$)
 - d) Ohm's law applies, but only for large resistances ($R > 10^4 \Omega$)
72. **The reason that the oscillation of an RLC oscillatory circuit is damped is:**
- a) non-zero capacitance and inductance of the oscillatory circuit
 - b) non-zero inductance of the oscillatory circuit
 - c) non-zero capacitance of the inductive circuit
 - d) non-zero resistance of the oscillatory circuit
73. **Which physical principles are correct for the devices listed below?**
- a) galvanic cell – conversion of chemical energy to electrical energy
 - b) thermistor – dependence of semiconductor electrical resistance on temperature
 - c) resistance thermometer – difference in thermal expansion between two metals
 - d) semiconductor diode – one PN junction

74. **In a cyclotron (particle accelerator), the trajectory of moving particles in an external magnetic field is curved into a circle due to the action of the magnetic Lorentz force. This means that:**
- a) electrons curve in the opposite direction to protons
 - b) neutrons cannot be accelerated in a cyclotron
 - c) greater magnetic induction causes greater curvature of the path
 - d) the higher the velocity of the particles, the greater the force with which they are deflected
75. **In ionized gases, the following can participate in current conduction:**
- a) only positively and negatively charged ions
 - b) only electrons
 - c) neutrons
 - d) electrons, both positively and negatively charged ions
76. **In a changing magnetic field, the vector of magnetic induction:**
- a) changes over time
 - b) always cancels out
 - c) does not change
 - d) does not change over time
77. **In an alternating current circuit with angular frequency ω and inductance L , the relationship for inductance X_L is given by:**
- a) $X_L = L \cdot \omega^2/2$
 - b) $X_L = 1/(\omega \cdot L)$
 - c) $X_L = L/\omega$
 - d) $X_L = \omega \cdot L$
78. **If we connect a diode to an alternating current circuit so that the diode works as a half-wave rectifier, then:**
- a) the output voltage is alternating and pulsating, and alternating current flows through the circuit
 - b) the output voltage is direct and pulsating, and direct current flows through the circuit
 - c) the output voltage is direct and constant
 - d) the output voltage is alternating

79. ω is the angular frequency of the source of a harmonic signal to which an oscillator is connected, and ω_0 is the angular frequency of the natural oscillation of the oscillator. Resonance occurs when the following condition is met:
- a) $\omega \gg \omega_0$
 - b) $\omega = \omega_0$
 - c) $\omega = 10 \cdot \omega_0$
 - d) $\omega \ll \omega_0$

Electromagnetic Radiation

80. The more optically dense the medium:

- a) the higher the frequency of the wave passing through the medium
- b) the higher the wave velocity
- c) the lower its refractive index
- d) the higher its refractive index

81. Isotropic substances:

- a) have a different velocity of light propagation in different directions
- b) have the same velocity of light propagation in all directions
- c) rotate the plane of polarised light
- d) are poor conductors of heat

82. One type of cells found in the eye is called rods. These cells:

- a) are located on the retina
- b) enable black and white vision
- c) enable colour vision
- d) are located in the eye lens

83. Electromagnetic radiation includes:

- a) ultrasound
- b) ultraviolet radiation
- c) X-ray radiation
- d) gamma radiation

84. **The light that most closely resembles monochromatic light is emitted by:**

- a) incandescent bulbs
- b) fluorescent lamps
- c) the sun
- d) lasers

85. **Optically active substances:**

- a) reflect all incident light
- b) have the ability to create optical radiation
- c) absorb all light incident on them
- d) have the ability to rotate the plane of oscillation of polarised light

86. **For the wavelength λ of electromagnetic radiation, the following applies (c is the velocity of light and f is the frequency of the radiation):**

- a) $\lambda = f/c$
- b) $\lambda = c/f$
- c) $\lambda = c \cdot f$
- d) $\lambda = 1/(c \cdot f)$

87. **When passing through the interface of optical mediums:**

- a) the frequency of the light changes
- b) the velocity of the light does not change
- c) the frequency of the light does not change, but the velocity of light propagation does change
- d) the wavelength of the light does not change

88. **Light is a:**

- a) transverse mechanical wave (in solid substances)
- b) transverse electromagnetic wave
- c) longitudinal electromagnetic wave
- d) stream of photons

89. **Ultraviolet radiation:**

- a) has a higher frequency than visible light
- b) has shorter wavelengths than visible light
- c) has shorter wavelengths than X-ray radiation
- d) has a higher frequency than infrared radiation

Atomic Physics

90. **A perfect black body:**

- a) reflects and radiates
- b) reflects perfectly
- c) only absorbs
- d) absorbs and radiates

91. **Absorption of electromagnetic radiation:**

- a) is a process in which incoming photons are absorbed by matter and cause atoms to transition to a higher energy state
- b) always causes the release of an electron from the atom
- c) leads to the absorption of electrons from the shell by the atomic nucleus
- d) means the process of releasing energy from atoms in the form of photons

92. **The activity of a radioactive sample:**

- a) is the number of nuclei that transform in 1 second
- b) decreases exponentially with time
- c) decreases logarithmically with time
- d) has the same physical unit as the half-life

93. **Two isotopes of the same element have a different number of:**

- a) protons
- b) neutrons
- c) nucleons
- d) electrons

94. **An excited state of an atom refers to:**

- a) a state where the atom has accepted an electron from another atom
- b) a state where the atom has released at least one electron
- c) a state with higher energy values of the electrons in the shell than in the ground state
- d) a state with a higher number of nucleons in the nucleus

95. **Gamma radiation:**

- a) is electromagnetic radiation
- b) is a stream of neutrons
- c) is a stream of photons
- d) is not deflected by an electric field

96. **The nucleus of carbon $^{12}_6\text{C}$ contains:**

- a) 6 neutrons
- b) 6 nucleons
- c) 12 protons
- d) 12 electrons

97. **During radioactive decay, the number of radioactive atoms in the sample decreases over time approximately:**

- a) linearly
- b) exponentially
- c) logarithmically
- d) in an inverse square way

98. **The dimensions of an atom are on the order of:**

- a) 1 pm
- b) 0.1 μm
- c) 100 nm
- d) 100 μm

99. **Alpha radiation:**

- a) consists of helium nuclei
- b) is attracted to a negatively charged electrode
- c) contains fast electrons
- d) contains free fast protons and neutrons

100. **Beta radiation consists of:**

- a) protons
- b) electrons
- c) photons
- d) helium nuclei

Biology

Intro to Biology

1. **Gamete is a general term for:**
 - a) germ cell
 - b) sex chromosome
 - c) a cell formed by the fusion of sex cells
 - d) gonad
2. **An example of asexual reproduction is:**
 - a) mitotic division in unicellular organisms
 - b) budding in hydra
 - c) reproduction of plants by cuttings
 - d) strobilation in jellyfish
3. **Ethology is a branch of science that studies:**
 - a) the movements of plants
 - b) the systematics and phylogeny of insects
 - c) the behaviour of animals
 - d) the relationships between organisms and environmental factors
4. **An enzyme is:**
 - a) synonym for any protein
 - b) any protein of yeast origin
 - c) protein catalyst of metabolic processes
 - d) non-protein coenzyme activator
5. **Chlorophyll:**
 - a) is present exclusively in plant mitochondria
 - b) is mostly freely dissolved in the cytoplasm of plant cells
 - c) is present in chloroplasts
 - d) contains a magnesium atom in its molecule

Molecular biology

6. **The current central dogma of molecular biology postulates the flow of genetic information:**
 - a) from DNA to DNA during replication
 - b) from proteins to DNA
 - c) from proteins to polysaccharides
 - d) from DNA to RNA
7. **Circular DNA molecules can be present:**
 - a) in bacterial cells
 - b) in some viruses
 - c) in chloroplasts
 - d) in mitochondria
8. **The introduction of foreign DNA into a bacterial cell using a bacteriophage is called:**
 - a) translocation
 - b) conjugation
 - c) transcription
 - d) transduction
9. **The polypeptide strand of a bacterial protein consists of 202 amino acids. What will be the length of the respective coding sequence of the respective mRNA (without the STOP codon)?**
 - a) 202 nucleotides
 - b) 303 nucleotides
 - c) 606 nucleotides
 - d) 101 nucleotides
10. **Which of these molecules is/are directly involved in the translation process?**
 - a) tRNA
 - b) hnRNA
 - c) mRNA
 - d) DNA polymerase
11. **Exons:**
 - a) are sections of the gene present in mature mRNA
 - b) are sections of the gene that are not replicated
 - c) are sections of the gene that do not participate in translation
 - d) are non-coding genomic sequences that are not part of genes

12. **The DNA molecules responsible for extranuclear inheritance are present:**

- a) in the nucleus
- b) in mitochondria
- c) in chloroplasts
- d) in ribosomes

13. **Ames test:**

- a) determines the mutagenicity of chemical substances using special strains of bacteria
- b) is based on the induction of gene mutations in bacteria
- c) detects chromosome mutations in mammalian cells after application of the test substance
- d) evaluates the genotoxicity of chemical substances using studies of genetic disorders in exposed human populations

14. **What is a codon? (Do not consider STOP codons)**

- a) a triplet of nucleotides in tRNA that determines the addition of one amino acid to the polypeptide strand
- b) a triplet of nucleotides in rRNA that determines the attachment site of tRNA to the ribosome
- c) a triplet of nucleotides in mRNA that determines the addition of one amino acid to the polypeptide chain
- d) a triplet of nucleotides in mRNA, to which a certain tRNA attaches with its complementary anticodon

15. **Choose the correct statement(s) about proteins:**

- a) a polypeptide strand is composed mainly of nucleotides
- b) the primary structure of proteins has the character of an α -helix or a β -pleated sheet
- c) hydrogen bonds are also involved in the formation of the secondary structure of proteins
- d) the primary structure of proteins is determined by the sequence of amino acids

16. **The so-called initiation (START) codon:**

- a) is part of the promoter and indicates the beginning of transcription
- b) does not code for any amino acid
- c) in eukaryotes, it codes for methionine during translation
- d) indicates the beginning of DNA replication

17. **How many different codon variants can we find in mRNA molecules?**

- a) 20
- b) 22
- c) 64
- d) 96

18. **Which of the following amino acids contain(s) sulphur in its molecule?**
- a) glycine
 - b) methionine
 - c) valine
 - d) cysteine
19. **In retroviruses, which molecule is the template for viral DNA synthesis?**
- a) a specific protein called a prion
 - b) DNA
 - c) a specific retroprotein
 - d) RNA
20. **A technique called DNA-fingerprinting:**
- a) is mainly used for direct diagnosis of mutations in monogenic diseases
 - b) is a special technique that allows the isolation of DNA from fingerprints
 - c) enables the identification of persons in forensic medicine
 - d) is also used in paternity testing
21. **The breaking of hydrogen bonds between bases in complementary strands of DNA molecules is called:**
- a) DNA annihilation
 - b) DNA diffraction
 - c) DNA denaturation
 - d) DNA reassociation
22. **Frameshift mutations can be caused by:**
- a) insertion of one nucleotide
 - b) deletion of one nucleotide
 - c) substitution of one nucleotide for another nucleotide
 - d) deletion of two consecutive nucleotides
23. **Choose the correct statement(s) about codon:**
- a) a codon consists of three nucleotides
 - b) one codon usually codes for 2-4 different amino acids
 - c) the codon is located at one end of the tRNA molecule (the so-called codon arm)
 - d) a codon is the basic unit of the genetic code

24. **The technique referred to as PCR:**

- a) serves to cleave DNA using restriction endonucleases
- b) is called polymerase chain reaction
- c) enables the amplification of a selected DNA sequence
- d) usually uses a thermostable DNA polymerase

25. **Which enzyme connects ribonucleotides during RNA synthesis?**

- a) RNA transcriptase
- b) RNA polymerase
- c) RNA nuclease
- d) reverse transcriptase

26. **The share of cytosine (C) among bases in the chromosomal DNA of a certain mammal is 30%.**

What are the percentages of the other bases?

- a) adenine (A) 20%, thymine (T) 20%, guanine (G) 30%
- b) adenine (A) 20%, thymine (T) 30%, guanine (G) 20%
- c) guanine (G) 30%, the proportion of adenine (A) and thymine (T) cannot be clearly determined
- d) adenine (A) 30%, thymine (T) 20%, guanine (G) 20%

27. **Genetic code:**

- a) is significantly different in prokaryotic and eukaryotic organisms
- b) has changed considerably during recent evolution
- c) is defined as the collection of all DNA molecules in an organism
- d) is universal

Biology of bacteria and viruses

28. **Unlike eukaryotic cells, prokaryotic cells never contain:**

- a) cell wall
- b) ribosomes
- c) mitochondria
- d) chloroplasts

29. **A bacteriophage is:**

- a) a virus that attacks bacterial cells
- b) a special bacterium that engulfs bacterial viruses
- c) a large, membrane-enveloped bacterium-like virus that attacks animal cells
- d) an immune system cell (a type of macrophage) that engulfs bacteria

30. Select a group of human diseases that includes only viral infections:

- a) infectious jaundice (hepatitis A), AIDS, measles, chicken pox
- b) chicken pox, syphilis, infectious jaundice (hepatitis A), polio
- c) inflammation of the meninges, variant Creutzfeldt-Jakob disease, mumps, influenza
- d) tuberculosis, inflammation of the meninges, measles, infectious jaundice (hepatitis A)

31. A prion is:

- a) a protein infectious particle
- b) the immature stage of the virus
- c) the protein component of the viral particle
- d) an infectious RNA molecule formerly referred to as a viroid

32. A particle called a virion can contain:

- a) capsid
- b) RNA molecule
- c) DNA molecule
- d) membrane envelope

33. Peptidoglycan:

- a) is a protein forming the envelope of virions
- b) is an artificial dye used for microscopic identification of glycoproteins in bacterial cells
- c) is a basic component of the media on which bacteria are cultivated in the laboratory
- d) is the basic component of the cell wall of most bacteria

34. What happens during bacterial conjugation?

- a) the joining of two cells and the two-way mutual exchange of their chromosomes
- b) the joining of two cells, whereby part of the genetic information passes from one cell to the other one
- c) the complete fusion of two cells and their chromosomes leading to the formation of one daughter cell
- d) the fusion of two cells, whereby their chromosomes form a homologous pair

Biology of plants and fungi

35. Which substances are produced during photosynthesis? (Consider the typical course of photosynthesis in a green plant.)

- a) oxygen and carbon dioxide
- b) carbon dioxide and water
- c) oxygen, water and carbohydrates
- d) carbon dioxide, water and carbohydrates

36. Which of these plants are classified as dicotyledonous plants?

- a) sunflower (*Helianthus*)
- b) iris (*Iris*)
- c) rose (*Rosa*)
- d) pea (*Pisum*)

Biology of animals and protists

37. **Toxoplasma (Toxoplasma gondii):**

- a) is a bacterium producing toxic substances (especially botulinum toxin)
- b) belongs to the parasites that also attack humans
- c) causes the so-called sleeping sickness
- d) if it infects a pregnant woman, it can cause serious inborn defects in the newborn

38. **In chordates:**

- a) the chorda dorsalis is formed from the neural tube
- b) the chorda dorsalis arises from the ectoderm
- c) the chorda dorsalis arises from the chordamesoderm
- d) the neural tube is formed together with the dorsal chord (chorda dorsalis) by shedding the endoderm

39. **The crustaceans (Crustacea) do not include:**

- a) krill (*Euphausiacea*)
- b) copepods (*Copepoda*)
- c) spiders (*Aranae*)
- d) scorpions (*Scorpiones*)

40. **Trichomoniasis is most commonly transmitted by:**

- a) Anopheles mosquito
- b) ticks
- c) sexual intercourse
- d) infected rodents or rabbits

41. **Cetaceans include:**

- a) dolphin
- b) sperm whale
- c) sea lion
- d) walrus

42. **Protists from the genus Plasmodium are the causative agents of which human disease?**

- a) sleeping sickness
- b) bloody diarrhoea
- c) haemophilia
- d) malaria

Cell biology

43. **Which group(s) of organisms has/have the prokaryotic cell type:**

- a) protists
- b) archaea
- c) eubacteria
- d) cyanobacteria

44. **Plasma membrane:**

- a) is a single layer of phospholipid molecules
- b) is a double layer of phospholipid molecules
- c) contains transport proteins
- d) is engaged in endocytosis

45. **Mitochondria:**

- a) have no ribosomes
- b) have their own ribosomes different from the ribosomes in the cytoplasm of the cell
- c) have the same ribosomes as in the cytoplasm of the cell
- d) have some of their own specific ribosomes and some the same as those in the cell cytoplasm

46. **Telomere is:**

- a) the end of a linear chromosome in eukaryotic organisms
- b) the central region of the chromosome where sister chromatids meet
- c) the final phase of mitosis
- d) a cellular structure composed of microtubules that participates in mitosis

47. **Zygote:**

- a) is a male or female gamete
- b) is formed by the union of sex cells
- c) is a fertilized egg
- d) is the eight-cell stage of the furrowing embryo

48. **A human haploid cell contains:**

- a) 23 chromosomes
- b) 22 chromosomes
- c) 46 chromosomes
- d) always both sex chromosomes X and Y

49. **During meiosis, the following occurs:**

- a) the reduction of the number of chromosomes in the nuclei of cells
- b) the increase of the number of chromosomes in the nuclei of cells
- c) the segregation of chromosomes into gametes
- d) the crossing-over

50. **Polar body (polocyte):**

- a) arises during spermatogenesis
- b) is a diploid cell that arises at the end of oogenesis
- c) is the terminal part of the sperm head
- d) is a haploid cell that arises during oogenesis

51. **Prenatal examination of the cells of a human foetus revealed that each of them contains 47 chromosomes. What is the name for this chromosomal aberration?**

- a) monosomy
- b) diploidy
- c) triploidy
- d) trisomy

52. Submetacentric chromosome:

- a) has the same length of p- and q-arm
- b) has a p-arm shorter than a q-arm
- c) is a type of chromosome that is also found in the human karyotype
- d) is a general term for a very small chromosome that cannot be observed with an optical microscope

Genetics

53. Extranuclear inheritance in humans:

- a) is manifested by matrocliny
- b) is heredity linked to ribosomes, or ribosomal DNA
- c) manifests itself in all organisms in such a way that the offspring must always have the same phenotypic traits as the mother
- d) is mitochondrial and plastid inheritance

54. If a haemophilia A carrier has children with a healthy man, the children will be:

- a) half of daughters affected, half of sons affected
- b) half of daughters carriers, half of sons affected
- c) all daughters non-carriers, half of sons affected
- d) all daughters and sons affected

55. Two sons with haemophilia A, one healthy son and one healthy daughter were born to healthy parents. What are the genotypes of these family members?

- a) the mother is a carrier
- b) the daughter can be a carrier or a non-carrier
- c) both affected sons are hemizygotes carrying the haemophilia allele
- d) the father is a carrier, the mother has a normal genotype

56. Traits with multifactorial inheritance are affected by:

- a) additive effect of alleles
- b) interaction of genotype and environment
- c) interaction of a larger number of genes
- d) environmental influences

57. **A son affected by an autosomal dominant hereditary disease with full penetrance was born to completely healthy parents. What is a possible explanation?**

- a) both parents are heterozygotes, and the child is a dominant homozygote
- b) non-paternity must have occurred in the family
- c) the son's disease arose due to de novo mutation
- d) the mother is a carrier of the mutant allele, while the father is not

58. **Genealogy:**

- a) includes pedigree analysis
- b) is a necessary part of the clinical genetic examination
- c) consists, among other things, of filling in a pedigree questionnaire by the proband (propositus, index patient) or their relatives
- d) is the calculation of the gene linkage strength in centimorgans (cM)

59. **Which trait(s) can have monogenic inheritance in humans:**

- a) body height
- b) colour blindness (daltonism)
- c) intelligence
- d) all autoimmune diseases

60. **The sex chromosome Y is found in humans:**

- a) in half of sperm cells and half of male somatic cells
- b) in half of sperm cells and in all male somatic cells
- c) in all sperm and in all somatic male cells
- d) in all sperm and in half of male somatic cells

61. **Choose the correct statement (or statements) about phenylketonuria:**

- a) it is an autosomal recessive disease
- b) it is a severe type of diabetes, in which a high concentration of phenols and ketones (especially acetone) accumulates in the patient's urine
- c) if phenylketonuria is already detected in a newborn, the onset of its serious manifestations can be prevented with a suitable diet
- d) it is a disorder of the metabolic conversion of phenylalanine

62. **The population consists of:**

- a) only those individuals of the same species that have a completely identical genotype
- b) all individuals of the same species that live in a certain habitat and can interbreed
- c) organisms of different species that live in the same habitat and create an ecosystem
- d) all individuals that belong to one species and live in different, often very distant habitats

63. Alleles of one gene:

- a) may differ in terms of phenotypic expression
- b) occur at the same locus
- c) may not be the same
- d) may be responsible for the emergence of a certain character

64. Genome:

- a) is the set of all genes in a cell, or in the organism (without non-coding sequences)
- b) is a set of all DNA molecules in a cell, or in the organism
- c) is a synonym for genotype
- d) is significantly influenced by phenotype

65. Blood groups of the ABO system are inherited:

- a) as a monogenic trait, with significant participation of external environmental factors
- b) as a polygenic trait, without the participation of the external environment
- c) as a monogenic trait, without the participation of external environmental factors
- d) as a multifactorial trait

66. Alternative forms of genes at the same loci on homologous chromosomes are called:

- a) mutagens
- b) alleles
- c) pseudomorphisms
- d) pseudogenes

67. The set of alleles of a given individual is called (choose the most accurate term):

- a) genome
- b) genotype
- c) gene pool
- d) karyotype

68. In an ideal panmictic population, whose members reproduce exclusively sexually, the frequency of dominant homozygotes is 0.01. Based on the Hardy-Weinberg equilibrium, determine the frequency of recessive homozygotes:

- a) 0.5
- b) 0.18
- c) 0.81
- d) 0.99

69. In humans and fruit flies (*Drosophila*), the female sex is:

- a) heterozygous
- b) homogametic
- c) heterogametic
- d) autosomal

70. The Hardy-Weinberg equilibrium in the population is NOT disturbed by:

- a) sufficient population size
- b) mutation
- c) genetic drift
- d) panmixia

71. Mother has blood type B, Rh+, father has A, Rh-. Their child:

- a) can have blood groups O, Rh+
- b) cannot have blood groups AB, Rh-
- c) can have all blood types in both systems
- d) cannot have blood groups O, Rh+

Human biology

72. Deoxygenated blood is found in humans:

- a) in all veins
- b) in the pulmonary veins
- c) in the pulmonary arteries
- d) in the right atrium

73. The colour vision is enabled by

- a) rod cells
- b) optic disc (blind spot)
- c) vitreous body
- d) cone cells

74. Axon is:

- a) a long projection of a neuron
- b) the opposite of an intron
- c) a translated part of the gene
- d) a gene located in the axis of the chromosome

75. For an eye defect called short-sightedness (myopia):

- a) the biconcave lenses are used for the correction
- b) the biconvex lenses are used for the correction
- c) the image of more distant objects appears in front of the retina
- d) nearby objects appear behind the retina

76. Haematocrit is:

- a) blood dye in human erythrocytes
- b) a general designation for any pathological condition where haematopoiesis is critically reduced
- c) a device for automatic blood analysis
- d) a value that indicates the proportion of red blood cells in the total volume of blood

77. What is the frequency of a tone that produces a sound sensation in the human ear?

- a) 50 mHz
- b) 50 Hz
- c) 50 kHz
- d) 50 MHz

78. Cyanosis:

- a) is a rare genetic disease in which cyanide accumulates in the body
- b) is a designation for noticeably flushed to red skin, which indicates good blood circulation and high oxygen saturation of the blood
- c) can occur with carbon monoxide intoxication
- d) is a sign for bluish to blue discoloration of the skin and mucous membranes

79. Female sex hormones are mainly formed:

- a) in the ovaries
- b) in the pituitary gland (hypophysis cerebri)
- c) in the womb
- d) in the vagina

80. A nephron consists of:

- a) Bowman's capsule, glomerulus, proximal tubule, loop of Henle, distal tubule and collecting ducts
- b) Bowman's capsule, glomerulus, proximal tubule, loop of Henle and distal tubule
- c) the glomerulus only
- d) Bowman's capsule and glomerulus

81. Trypsinogen is produced by:

- a) liver
- b) gastric mucosa
- c) pancreas
- d) mucosa of the small intestine

82. After surgical removal of the gallbladder, the patient must be especially careful in taking:

- a) proteins
- b) fibre
- c) sugars
- d) fats

83. Which of the listed male organs is common to the urinary and reproductive systems?

- a) testicles
- b) urethra
- c) ureter
- d) prostate

84. Which of the listed tissues mostly forms the inner lining of organs?

- a) epithelial tissue
- b) connective tissue
- c) nervous tissue
- d) muscle tissue

85. Control of breathing movements:

- a) is affected by changes in the concentration of CO₂ and O₂ in the blood
- b) takes place through the respiratory centre in the medulla oblongata
- c) takes place through chemoreceptors in the aorta and carotid arteries
- d) is influenced by the central nervous system

86. Bile:

- a) is produced in the gallbladder
- b) facilitates the digestion of fats
- c) contains bile pigments, cholesterol and mucus
- d) is created in the liver

87. The production of thyroid hormones is mainly dependent on the intake of:

- a) iron
- b) copper
- c) potassium
- d) iodine

88. Long-term insufficient intake of vitamin D to the human body causes:

- a) formation of a goitre (also goitre)
- b) scurvy
- c) rickets
- d) a disease called beriberi

89. Human red blood cells:

- a) do not have a nucleus
- b) contain haemoglobin
- c) are not capable of independent movement
- d) their numbers are higher in the blood of women compared to the blood of men

90. Which cells are responsible for the cellular immune reaction (e.g. against transplants)?

- a) B lymphocytes
- b) platelets
- c) all types of leukocytes
- d) T lymphocytes

91. Cancerous diseases include:

- a) leukaemia
- b) lymphomas
- c) carcinomas
- d) sarcomas

92. Typical autoimmune diseases is/are:

- a) leukaemia
- b) allergic asthma
- c) Lyme disease
- d) multiple sclerosis

Evolutionary biology

93. **The first mammals appeared:**

- a) at the beginning of the Quaternary
- b) at the beginning of the Paleozoic during the so-called Cambrian radiation
- c) at the beginning of the Mesozoic
- d) at the beginning of the Tertiary

94. **Results of the study of mitochondrial DNA in different human populations:**

- a) prove that the modern man (*Homo sapiens*) arose independently in several places on Earth
- b) testifies to the so-called monocentric theory, according to which modern *Homo sapiens* most likely originated in Africa
- c) proves that the human species (*Homo sapiens*) originated in Central Europe
- d) testifies to the fact that modern *Homo sapiens* arose in Australia from *Australopithecus*

95. **According to evolutionary theories based on Darwinism, what is the role of natural selection?**

- a) natural selection causes that individuals with lower fitness also have a lower chance of producing offspring
- b) natural selection reproductively favours individuals whose genotype allows them to survive in given environmental conditions
- c) the mechanisms of natural selection directly cause favourable mutations in some individuals and thus enable the improvement of their reproductive abilities
- d) natural selection acts only in small populations and increases their size

96. **Which of the listed mammals is phylogenetically most closely related to humans?**

- a) macaque
- b) gorilla
- c) chimpanzee
- d) orangutan

Ecology

97. **The term biome refers to:**

- a) a set of individuals of one species that have the same genome
- b) the sum of all living organisms forming the biosphere on Earth
- c) a set of geographically delineated ecosystems with common features
- d) the cycle of a certain biogenic element

98. Eutrophication of water in lakes occurs most often:

- a) as a result of an increase in the concentration of inorganic nutrients (nitrates, phosphates etc.)
- b) as a result of acid rain, when the toxic effects of sulphur dioxide are manifested
- c) as a result of the supply of toxic metals from chemical plants or ore mines
- d) due to excessive fertilization of agricultural land

History of biology

99. Louis Pasteur:

- a) was the first researcher to accurately describe mitotic cell division
- b) performed vaccination against rabies for the first time
- c) developed vaccination against anthrax
- d) disproved the theory of spontaneous generation (abiogenesis) with his experiments

100. The Human Genome Project (HGP) was officially launched:

- a) at the beginning of the 20th century after the rediscovery of Mendel's laws
- b) in 1953 after the discovery of the double helix structure of DNA
- c) at the beginning of the 1940s in connection with research into the possible mutagenic effects of chemical warfare agents
- d) in the year 1990

Chemistry

General chemistry

- 1. The principal quantum number n :**
 - a) indicates the number of electrons
 - b) determines whether the electron belongs to one of the seven energy levels
 - c) determines the relative position of the orbitals in space
 - d) characterizes the rotational movement of electrons
- 2. The atom is fully characterized by:**
 - a) its atomic and nucleon number
 - b) its proton number
 - c) its nucleon number
 - d) its neutron number
- 3. Isotopes of the same element are nuclides that:**
 - a) differ in the charge of the nucleus
 - b) differ in nucleon number
 - c) differ only in atomic number
 - d) have the same proton number
- 4. Alpha radiation is:**
 - a) a stream of positrons
 - b) a stream of electrons
 - c) a stream of photons
 - d) a stream of helium nuclei
- 5. The group of alkali metals includes:**
 - a) Sr
 - b) Sc
 - c) Cs
 - d) Be
- 6. The group of halogens does not include:**
 - a) F
 - b) Cl
 - c) Br
 - d) B

7. **Which noble gas is the most abundant in the Earth's atmosphere?**
- a) argon
 - b) helium
 - c) neon
 - d) hydrogen
8. **Choose the element with the highest electronegativity:**
- a) sodium
 - b) oxygen
 - c) carbon
 - d) aluminum
9. **Anions are easily formed from:**
- a) s elements
 - b) elements with high electron affinity
 - c) elements with low electron affinity
 - d) elements with low ionization energy
10. **Which of the following elements have the same number of valence electrons as nitrogen?**
- a) oxygen
 - b) phosphorus
 - c) tin
 - d) arsenic
11. **The main biogenic macroelements include:**
- a) N
 - b) Co
 - c) Fe
 - d) Cu
12. **What atom is bound in the heme molecule?**
- a) magnesium
 - b) sodium
 - c) manganese
 - d) iron

13. Which quantity describes the ability of an atom to attract shared electrons?

- a) activation energy (E_A)
- b) atomic electronegativity (X)
- c) proton number (Z)
- d) ionization energy (E_i)

14. Which of the following molecule(s) is/ are polar?

- a) CH_4
- b) H_2O
- c) C_6H_6
- d) HF

15. In an exothermic reaction, heat is:

- a) absorbed
- b) released
- c) consumed
- d) does not change

16. What is the importance of a catalyst in a chemical reaction?

- a) it does not affect the reaction rate
- b) reduces the activation energy
- c) decreases the rate of reaction
- d) increases the activation energy

17. The equilibrium of precipitation reactions is characterized by:

- a) pH
- b) Avogadro's constant
- c) the ionic product of water
- d) solubility product

18. Heterogeneous dispersion systems include:

- a) aqueous NaOH solution
- b) blood
- c) milk
- d) brass

19. The hydrogen exponent is defined by:

- a) $\text{pH} = -\log[\text{H}_3\text{O}^+]$
- b) $\text{pH} = -\ln[\text{H}_3\text{O}^+]$
- c) $\text{pH} = \log[\text{H}_3\text{O}^+]$
- d) $\text{pOH} = -\log[\text{H}_3\text{O}^+]$

20. Decide which of the following statement is true for an alkaline environment:

- a) $[\text{OH}^-] < [\text{H}_3\text{O}^+]$
- b) $[\text{H}_3\text{O}^+] < [\text{OH}^-]$
- c) $[\text{H}_3\text{O}^+] = [\text{OH}^-]$
- d) $[\text{H}_3\text{O}^+] > [\text{OH}^-]$

Inorganic chemistry

21. Which of the following oxides react with water to form hydroxides?

- a) SiO_2
- b) K_2O
- c) Cl_2O_7
- d) CaO

22. Which of the following oxides react with water to form oxygen-containing acid?

- a) CO
- b) N_2O_5
- c) SO_3
- d) N_2O

23. What is/are the product(s) of the reaction of ionic hydrides with water?

- a) H_3O^+
- b) Ionic hydrides do not react with water
- c) H_2
- d) O_2

24. The reaction of calcium carbide and water produces calcium hydroxide and:

- a) ethylene
- b) acetylene
- c) ethane
- d) carbon dioxide

25. What is the formula of the compound formed between Fe^{3+} and Cl^- ions?

- a) FeCl_3
- b) FeCl_2
- c) FeCl
- d) Fe_2Cl_3

26. $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$ is the formula of:

- a) ammonium chromate
- b) ammonium dichromate
- c) ammonium perchromate
- d) ammonium peroxochromate

27. Which of the following gases are highly poisonous to humans?

- a) He
- b) N_2
- c) Cl_2
- d) COCl_2

28. What is the formula of the tetraoxophosphoric acid?

- a) H_3PO_4
- b) H_2PO_4
- c) HPO_4
- d) $\text{H}_4\text{P}_2\text{O}_7$

29. Which of the following compounds is/are weak electrolyte(s)?

- a) potassium carbonate
- b) ammonia
- c) ammonium chloride
- d) sodium chloride

30. Which of the following compounds is/are strong acid(s)?

- a) HClO_4
- b) H_2CO_3
- c) HCl
- d) HCN

31. **What type of reaction is acid base neutralization?**
- a) protolytic reaction
 - b) redox reaction
 - c) chemical decomposition
 - d) proteolysis
32. **Which of the following salts will react alkaline in aqueous solution?**
- a) NH_4Cl
 - b) Na_2CO_3
 - c) Na_2SO_4
 - d) Na_2SO_3
33. **What is the oxidation number of phosphorus in the P_4 molecule?**
- a) 0
 - b) V
 - c) III
 - d) IV
34. **In an oxidation-reduction reaction, reducing agent undergoes:**
- a) reduction
 - b) neutralization
 - c) oxidation
 - d) dissociation
35. **In the reaction $\text{Zn} + 2 \text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$:**
- a) hydrogen cation acts as an oxidizing agent
 - b) zinc acts as an oxidizing agent
 - c) hydrogen cation is reduced and the zinc is oxidized
 - d) zinc is reduced and chlorine is oxidized
36. **Reduction can be characterized as:**
- a) hydrogenation
 - b) acceptance of electron(s)
 - c) dehydrogenation
 - d) hydration

37. In the electrolysis of molten KCl, which product forms at the cathode?

- a) K
- b) O₂
- c) H₂
- d) Cl₂

38. Choose the correct statement(s) about electrolysis:

- a) *Anode* is the electrode where reduction takes place.
- b) *Cathode* is the electrode where reduction takes place.
- c) *Anode* is the electrode where oxidation takes place.
- d) *Cathode* is the electrode where oxidation takes place.

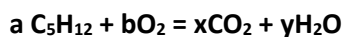
39. Reaction of gas chlorine with aqueous hot sodium hydroxide produces chlorates:



Which of the following contains the correct stoichiometric coefficients?

- a) $a = 3, b = 6, x = 1, y = 5, z = 3$
- b) $a = 1, b = 1, x = 1, y = 1, z = 1$
- c) $a = 4, b = 5, x = 3, y = 2, z = 2$
- d) $a = 2, b = 2, x = 1, y = 1, z = 2$

40. Pentane reacts with oxygen to form carbon dioxide and water:



Which of the following contains the correct stoichiometric coefficient for oxygen?

- a) $b = 6$
- b) $b = 4$
- c) $b = 8$
- d) $b = 3$

Chemical calculations

41. Determine the mass of oxygen present in sodium carbonate per 50 grams of sodium:

$$A_r(\text{Na}) = 23, A_r(\text{C}) = 12, A_r(\text{O}) = 16$$

- a) 34.78 grams of oxygen
- b) 52.17 grams of oxygen
- c) 47.91 grams of oxygen
- d) 104.34 grams of oxygen

42. How many grams of crystal water does 15 grams of blue rock $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ contain?

$$A_r(\text{Cu}) = 64, A_r(\text{S}) = 32, A_r(\text{O}) = 16, A_r(\text{H}) = 1$$

- a) 5.40 g
- b) 6.70 g
- c) 8.38 g
- d) 5.01 g

43. Determine which of the following compounds has the highest nitrogen percentage:

$$A_r(\text{N}) = 14, A_r(\text{S}) = 32, A_r(\text{Na}) = 23, A_r(\text{O}) = 16, A_r(\text{H}) = 1, A_r(\text{Cl}) = 35$$

- a) ammonium chloride
- b) sodium nitrite
- c) sodium nitrate
- d) ammonium sulphate

44. What amount of aluminum is contained in 1 mole of aluminum oxide?

- a) 3 mol
- b) 4 mol
- c) 2 mol
- d) 1 mol

45. Calculate the amount of substance of 10 grams of copper. How many atoms are contained in this amount of copper?

$$A_r(\text{Cu}) = 64$$

- a) 0.156 mol; $9.41 \cdot 10^{22}$ atoms
- b) 10 mol; $60.23 \cdot 10^{23}$ atoms
- c) 0.156 mol; $9.48 \cdot 10^{-23}$ atoms
- d) $1.56 \cdot 10^{-1}$ mol; $0.941 \cdot 10^{23}$ atoms

46. How many grams of NaOH are contained in 2 dm^3 of a solution with substance concentration $c(\text{NaOH}) = 0.05 \text{ mol dm}^{-3}$?

$$A_r(\text{Na}) = 23, A_r(\text{O}) = 16, A_r(\text{H}) = 1$$

- a) 4 g
- b) 2 g
- c) 40 g
- d) 0.05 g

47. Calculate the molar concentration of NH_4Br , if you know that 1.5 dm^3 of this solution contains

147 g of NH_4Br :

$$A_r(\text{N}) = 14, A_r(\text{Br}) = 80, A_r(\text{H}) = 1$$

- a) 1 mmol dm^{-3}
- b) 0.1 mmol dm^{-3}
- c) 0.1 mol dm^{-3}
- d) 1 mol dm^{-3}

48. You know that 0.400 dm^3 of a KCl solution contains 12 grams of KCl . Calculate the substance concentration of the KCl in this solution:

$$A_r(\text{K}) = 39, A_r(\text{Cl}) = 35$$

- a) 4.05 mol dm^{-3}
- b) 1.61 mol dm^{-3}
- c) $0.405 \text{ mol dm}^{-3}$
- d) $0.161 \text{ mol dm}^{-3}$

49. Nitrogen dioxide combines with water to form nitric acid and nitric oxide.

The reaction is described by the equation $3 \text{ NO}_2 + \text{H}_2\text{O} \rightarrow 2 \text{ HNO}_3 + \text{NO}$. Calculate the amount of the HNO_3 substance which can be produced from 0.06 mol of NO_2 :

- a) 0.04 mol
- b) 0.06 mol
- c) 0.02 mol
- d) 0.03 mol

50. How many grams of sodium hydroxide are needed for the preparation of 350 grams of the solution with mass fraction $w(\text{NaOH}) = 0.08$?

- a) 35 g
- b) 28 g
- c) 8 g
- d) 16 g

51. We mix 21 g of a 14% sodium iodide solution with a 10% solution of the same compound. How many grams of the 10% solution are needed to give an 11% solution of sodium iodide?

- a) 57.0 g
- b) 63.0 g
- c) 10.0 g
- d) 8.3 g

52. Calculate the volume of water needed to prepare 0.45 dm^3 of an acetic acid solution if you know that the final volume fraction of acetic acid in that solution is 30%:

- a) 315 cm^3
- b) 450 cm^3
- c) 300 cm^3
- d) 135 cm^3

53. We mixed 250 grams of nitric acid with mass fraction $w(\text{HNO}_3) = 0.08$ and 90 grams of water. Calculate the mass fraction in % of the nitric acid in this final solution:

- a) 6.45 %
- b) 4.07 %
- c) 5.88 %
- d) 8.0 %

54. What amount of carbon monoxide occupies a volume of 140 dm^3 under normal conditions?

$$A_r(\text{C}) = 12, A_r(\text{O}) = 16$$

- a) 132 grams
- b) 275 grams
- c) 175 grams
- d) 140 grams

55. Calculate the volume of nitrogen, which is theoretically needed for the preparation of 56 dm^3 of ammonia, if the reaction is: $\text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3$:

$$A_r(\text{H}) = 1, A_r(\text{N}) = 14$$

- a) 1.25 mol
- b) 28 dm^3
- c) 14 dm^3
- d) 0.56 dm^3

56. Calculate the pH of a $1 \cdot 10^{-4} \text{ mol dm}^{-3} \text{ HNO}_3$ solution:

- a) 4
- b) 10
- c) 3
- d) 10^{-4}

57. We have a solution of HNO_3 , in which the molar concentration of the H_3O^+ ion is equal to 0.01 mol dm^{-3} . For this solution, it holds that:
- a) its pH is 2
 - b) its pH is 1
 - c) the molar concentration of HNO_3 is equal to $1 \cdot 10^{-2} \text{ mol dm}^{-3}$
 - d) the molar concentration of OH^- is equal to $1 \cdot 10^{-12} \text{ mol dm}^{-3}$
58. Calculate the concentration of OH^- in a 1 mM aqueous solution of HCl.
- a) $10^{-11} \text{ mol dm}^{-3}$
 - b) $10^{-7} \text{ mol dm}^{-3}$
 - c) $10^{-3} \text{ mol dm}^{-3}$
 - d) $10^{-14} \text{ mol dm}^{-3}$
59. The substance concentration of hydroxide ions in an aqueous solution is $1 \cdot 10^{-8} \text{ mol dm}^{-3}$. Calculate the pH of this solution and decide whether the solution is acidic or alkaline:
- a) the solution is acidic; pH = 6.0
 - b) the solution is basic; pH = 6.0
 - c) the solution is basic; pH = 8.0
 - d) the solution is acidic; pH = 8.0
60. What is the pH of the solution prepared by mixing 10 ml of a $0,1 \text{ mol dm}^{-3}$ NaOH solution with 90 ml of water?
- a) 2
 - b) 13
 - c) 12
 - d) 11

Organic chemistry

61. Reactions of chlorine with CH_4 and with C_2H_4 are:
- a) additions
 - b) eliminations
 - c) a substitution and an addition
 - d) substitutions

62. Electrophilic reagent(s) is/are:

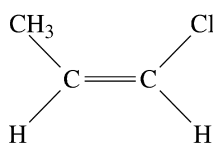
- a) H_3O^+
- b) OH^-
- c) H_2O
- d) NO_2^+

63. Vinyl alcohol and acetaldehyde are:

- a) enantiomers
- b) optical isomers
- c) tautomers
- d) conformational isomers

64. The compound with this formula is called:

- a) 3-chloro-prop-2-ene
- b) *cis*-1-chloro-prop-1-ene
- c) *trans*-1-chloro-prop-1-ene
- d) 1-methyl-3-chloro-eth-1-ene



65. The molecule which contains seven σ bonds is:

- a) acetic acid
- b) acetone
- c) ethanol
- d) acetaldehyde

66. How many alkyls can be derived from butane?

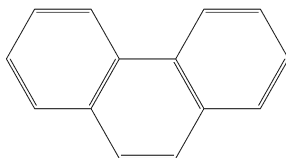
- a) four
- b) two
- c) one
- d) three

67. *p*-xylene is:

- a) 1,2-dimethylbenzene
- b) 1,4-dimethylbenzene
- c) methylbenzene
- d) 2-methyl-4-ethylbenzene

68. The compound with this formula is called:

- a) anthracene
- b) naphthalene
- c) biphenyl
- d) phenanthrene



69. Carotenoids belong to

- a) heterocycles
- b) tetraterpenes
- c) steroids
- d) alkaloids

70. Can an alcohol with three carbons in the molecule be a tertiary alcohol?

- a) yes, it depends on the number of -OH
- b) no, never
- c) yes, if it is trivalent
- d) yes, it depends on the -OH position

71. The product of methanol oxidation can be:

- a) acetic acid
- b) methanal
- c) ethanol
- d) acetaldehyde

72. Quinones can be formed by:

- a) oxidation of phenols with two -OH groups in the *ortho* position
- b) oxidation of phenols with two -OH groups in the *para* position
- c) oxidation of phenols with two -OH groups in the *meta* position
- d) oxidation of phenols with one -OH group

73. Compounds of phenols with sodium hydroxide can be classified as:

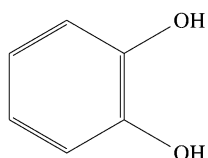
- a) esters
- b) salts
- c) soaps
- d) ethers

74. Formaldehyde is formed by dehydrogenation of:

- a) formic acid
- b) methanol
- c) ethane
- d) acetaldehyde

75. The compound with this formula is called:

- a) *o*-benzenediol
- b) benzene-1,2-diol
- c) pyrocatechol
- d) resorcinol



76. How many carbon atoms does a molecule of phenyl(methyl)ketone contain?

- a) seven
- b) five
- c) ten
- d) eight

77. Which of these molecules is/are ether(s)?

- a) $\text{HCO}-\text{CH}_3$
- b) $\text{CH}_3-\text{O}-\text{CH}_3$
- c) $\text{CH}_3-\text{CO}-\text{CH}_3$
- d) $\text{CH}_3-\text{CO}-\text{O}-\text{CH}_3$

78. Esterification is the reaction of:

- a) alcohols with inorganic acids
- b) alcohols with carboxylic acids
- c) alcohols with strong bases
- d) carboxylic acids with strong bases

79. Pyruvic acid is formed from lactic acid by:

- a) dehydration
- b) decarboxylation
- c) isomerization
- d) dehydrogenation

80. Urea is:

- a) purine derivative
- b) amino acid
- c) carbonic acid diamide
- d) acetic acid diamide

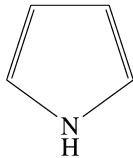
Biochemistry

81. Which of the following belong(s) to oxygen-containing heterocyclic compounds?

- a) imidazole
- b) thiophene
- c) furan
- d) pyridine

82. The compound represented by this structural formula is called:

- a) pyrimidine
- b) pyrrole
- c) purine
- d) pyridine



83. The building blocks of disaccharide lactose are:

- a) D-fructofuranose and D-glucopyranose
- b) 2-deoxy-D-ribose and D-glucopyranose
- c) D-glucopyranose and D-glucopyranose
- d) D-galactopyranose and D-glucopyranose

84. Which of the following does not belong to polysaccharides?

- a) amylose
- b) maltose
- c) cellulose
- d) insulin

85. Oleic acid is:

- a) a saturated fatty acid
- b) a short-chain fatty acid
- c) an unsaturated fatty acid
- d) an aromatic fatty acid

86. The basic type of bond between glycerol and a fatty acid residue in an acylglycerol (glyceride) is the:

- a) glycosidic bond
- b) hydrolytic bond
- c) ether bond
- d) ester bond

87. Which of the following vitamins are classified as water soluble:

- a) retinol
- b) calciferols
- c) biotin
- d) riboflavin

88. The human body requires vitamin K:

- a) to keep blood clotting functional
- b) to prevent night-blindness
- c) for correct bone development
- d) as a protection against scurvy

89. Which of the following compounds have/has a steroid structure:

- a) corticosteroids
- b) adrenaline
- c) cholesterol
- d) testosterone

90. The pancreas produces:

- a) insulin
- b) glucagon
- c) parathormone
- d) adrenalin

91. The essential amino acids in the human body:

- a) are produced by keto acid oxidation
- b) are produced by keto acid transamination
- c) are not produced, they are supplied in the diet
- d) are produced by keto acid dehydrogenation

92. Which of the following amino acids contain(s) sulphur in its molecule?

- a) tryptophan
- b) alanine
- c) serine
- d) cysteine

93. Mark the correct sequence of atoms in the main chain of a protein molecule:

- a) $-N-C-C-N-C-C-N-C-$
- b) $-N-C-N-C-$
- c) $-N-C-O-C-N-C-O-$
- d) $-S-S-C-S-S-C-$

94. Proteins:

- a) may have a secondary structure in the form of β -folded sheet or α -helix
- b) are composed of L-amino acids
- c) are composed of D-amino acids
- d) are all well soluble in water

95. Collagen occurs mainly in:

- a) skin and tendons
- b) blood and urine
- c) natural silk
- d) milk

96. Coenzyme is:

- a) a radical
- b) another name for substrate
- c) the enzyme's protein molecule itself
- d) a non-protein molecule necessary for the enzyme to function

97. During its β -oxidation, the fatty acid gets degraded stepwise to:

- a) acetyl coenzyme A
- b) pyruvic acid
- c) lactic acid
- d) acylglycerol

98. In humans, the main end product of the metabolism (biodegradation) of protein nitrogen is:

- a) ammonia
- b) purine bases
- c) uric acid
- d) urea

99. Which of the following belongs to the monosaccharide components of nucleic acids?

- a) 2-deoxy-D-ribose
- b) D-ribose
- c) D-ribulose
- d) L-ribose

100. Which purine bases are components of nucleic acids?

- a) adenine
- b) cytosine
- c) thymine
- d) guanine

Correct answers

Biophysics

1. **9.81 Pa can be expressed as:**
 - a) 1 N
 - b) $9.81 \text{ kg} \cdot \text{m}^{-1} \cdot \text{s}^{-2}$**
 - c) $9.81 \text{ N} \cdot \text{m}^2$
 - d) 9.81 N m^{-2}
2. **A rectangular prism-shaped aquarium has a height of 75 cm; two-thirds of its volume is filled with water. The aquarium stands on a flat, solid base, and its side walls are subjected to the internal pressure of the water and the external atmospheric pressure. Then the following holds true:**
 - a) The pressure difference between the liquid at the bottom and the pressure on the base is zero**
 - b) The pressure on the side wall at the bottom is 7.5 kPa
 - c) The pressure on the side wall just below the surface is 100 kPa
 - d) The pressure on the side wall at the bottom is 5000 Pa**
3. **A car with a total weight of 1000 kg starts moving from rest on a horizontal road and reaches a velocity of 20 m/s in 10 seconds. Its engine power, disregarding losses, must have been at least:**
 - a) 1000 W
 - b) 2 kW
 - c) 20 kW**
 - d) 200,000 J
4. **Within 10 minutes, we need to pump out 10 hectolitres of water from a depth of 10 metres, the efficiency of the pump is 90%. Then:**
 - a) A power input of 150 W will be sufficient
 - b) the pump will consume at least 1 kWh of energy
 - c) The potential energy of the water will increase by 100 kJ**
 - d) The pump flow rate will be $0.1 \text{ m}^3 \cdot \text{min}^{-1}$**
5. **Bernoulli's equation for the flow of an ideal fluid in a horizontal pipe is given by (p – fluid pressure, ρ – fluid density, V – volume, v – flow velocity, m – mass):**
 - a) $p + \rho \cdot v^2 = \text{const.}$
 - b) $p \cdot V + 1/2 \cdot \rho \cdot v^2 = \text{const.}$
 - c) $p + 1/2 \cdot \rho \cdot v^2 = \text{const.}$**
 - d) $p + 1/2 \cdot m \cdot v^2 = \text{const.}$
6. **Bernoulli's equation expresses:**
 - a) The law of conservation of energy of an ideal fluid**
 - b) The law of conservation of momentum of an ideal fluid
 - c) The dependence of gas pressure on temperature
 - d) The dependence of turbulence in the fluid on velocity

7. Two small masses, each with a mass of 50 kg, placed at a distance of 50 cm from each other, attract each other with a gravitational force of ($\kappa = 6.67 \cdot 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2$):
- $6.67 \cdot 10^{-11} \text{ N}$
 - $6.67 \cdot 10^{-7} \text{ N}$**
 - $6.67 \cdot 10^{-9} \text{ N}$
 - $3.34 \cdot 10^{-7} \text{ N}$
8. Two containers with liquid are closed with a movable circular piston. In the first container, a force F acts on the piston with a radius r , creating a pressure p in the liquid. In the second container, the same force F acts on the piston with a radius of $2r$. The pressure in the second liquid will be:
- $2p$
 - $4p$
 - $p/2$
 - $p/4$**
9. Two containers with liquid are closed with a movable piston. In the first container, a force F acts on the piston with an area S , creating a pressure p in the liquid. In the second container, the same force F acts on the piston with an area of $2S$. The pressure in second liquid will be p :
- $2p$
 - $4p$
 - $p/2$**
 - $p/4$
10. Two containers with the same base area, one cylindrical and the other conically narrowing, are filled with water to the same height. Then:
- Both containers will have the same force acting on the bottom, because the base areas of the containers and the heights of the liquid are equal**
 - Both containers will have different forces acting on the bottom, because the volume of liquid in the containers differs
 - Both containers will have the same hydrostatic pressure at the bottom, because the height of the liquid in the containers is the same**
 - Both containers will have different hydrostatic pressures at the bottom, because the mass of the liquid in the containers is different
11. An action-reaction pair of forces are:
- Any two forces of opposite direction
 - Two forces of equal magnitude and opposite direction, lying on a straight line
 - Two forces of equal magnitude and opposite direction, acting on different bodies**
 - Two forces of the same direction, acting on the same body

12. The gravitational constant has a numerical value of $6.67 \cdot 10^{-11}$ when using the SI system. From the law of gravitation, we can deduce that its unit is:
- N
 - $\text{N} \cdot \text{kg}^2/\text{m}^2$
 - $\text{N} \cdot \text{m}^2/\text{kg}^2$**
 - $\text{m}^3/(\text{s}^2 \cdot \text{kg})$
13. The gravitational potential energy of a body of mass m at a small height h above the Earth is expressed by the relation (K – intensity of the gravitational field; assuming that $E_p = 0$ for $h = 0$):
- $E_p = m \cdot K/h$
 - $E_p = m \cdot K \cdot h/2$
 - $E_p = m \cdot K \cdot h$**
 - $E_p = m \cdot K \cdot h^2/2$
14. The value closest to the hydrostatic pressure at a depth of 10 m below the water surface is:
- 100 kPa**
 - 10,000 Pa
 - 106 Pa
 - 98.1 Pa
15. Hooke's law holds:
- Throughout the entire range of material deformation
 - Even in the area of plastic (permanent) deformation
 - Up to the limit of material strength
 - In the area of elastic deformation of the material**
16. An ideal gas:
- only absorbs heat
 - does not perform work when expanding
 - is incompressible
 - is perfectly compressible and without internal friction**
17. The SI unit of energy is:
- joule**
 - kilocalorie
 - newton
 - calorie
18. Regarding the 2nd law of thermodynamics:
- it implies that the entropy of an isolated thermodynamic system cannot increase
 - it implies that the entropy of an isolated thermodynamic system cannot decrease**
 - living systems do not violate it, as their entropy does not decrease
 - living systems do not violate it, as they are open systems**

19. For the work W performed by a gas at a constant pressure p , the following holds true (ΔT is the change in gas temperature, ΔV is the change in gas volume):
- a) W is always equal to zero
 - b) $W = p \cdot \Delta T$
 - c) **$W = p \cdot \Delta V$**
 - d) $W = p \cdot \Delta T \cdot \Delta V$
20. Heat can be transmitted through:
- a) **conduction in thermally conductive materials**
 - b) convection in fluids
 - c) radiation or emission
 - d) vacuum
21. A temperature of 0 Kelvin:
- a) corresponds to the melting point of ice at a pressure of 101.3 kPa
 - b) is the temperature at which liquid hydrogen solidifies
 - c) corresponds to a temperature of 273.15 °C
 - d) **is a state of matter that cannot be fully achieved, at which the thermal motion of molecules would cease**
22. Internal energy is:
- a) **the sum of the total kinetic energy of the randomly moving particles of a body and the total potential energy of the mutual positions of these particles**
 - b) only the energy of nucleons in the atomic nucleus
 - c) equal to the total potential energy of the mutual positions of particles
 - d) equal to the total kinetic energy of the randomly moving particles of a body
23. The basis of the kinetic theory of the structure of matter structure are three experimentally verified findings. Identify the statement that does not belong to this basis (and which is not true):
- a) matter of any state consists of particles
 - b) **particles do not exert any forces on each other**
 - c) particles mutually exert attractive and repulsive forces
 - d) particles move within the matter
24. The unit of heat capacity in SI base units is:
- a) **$\text{m}^2 \cdot \text{kg} \cdot \text{K}^{-1} \cdot \text{s}^{-2}$**
 - b) $\text{m}^2 \cdot \text{K} \cdot \text{s}^{-2}$
 - c) $\text{m}^2 \cdot \text{kg} \cdot ^\circ\text{C} \cdot \text{s}^{-2}$
 - d) $\text{m}^2 \cdot \text{K}^{-1} \cdot \text{s}^{-2}$

25. **Amorphous substances are:**
- isotropic**
 - artificially prepared, do not occur naturally
 - usually crystalline
 - anisotropic
26. **If we pour water into a container with a soluble solid colouring substance, the solution quickly colours just above the substance. The colouring will continue to spread upwards. This observed phenomenon is called:**
- surface tension
 - internal friction
 - osmosis
 - diffusion**
27. **If the specific latent heat of fusion of ice at 0 °C is 334 J·g⁻¹, the specific latent heat of vaporisation (boiling) at 100 °C is 2256 J·g⁻¹, and the specific heat capacity of water (in the temperature range 0 °C to 100 °C) is approximately 4200 J·kg⁻¹·K⁻¹; then the following hold true:**
- less heat is needed to heat water from 0 °C to 100 °C than to melt ice of the same mass at 0 °C
 - less heat is needed to heat water from 25 °C to 100 °C than to evaporate this amount of water at 100 °C**
 - less heat is needed to melt ice of a given mass at 0 °C than to evaporate water of the same mass at 100 °C**
 - the same amount of heat is needed to melt ice at 0 °C and heat water of the same mass to 40 °C as to heat water of the same mass from 0 °C to 40 °C
28. **Which of the following is not correct?**
- the unit of latent heat is J·K⁻¹**
 - the unit of specific latent heat of fusion is J·kg⁻¹
 - the unit of heat capacity of a body is J·K⁻¹
 - the unit of specific heat capacity is J·kg⁻¹·K⁻¹
29. **Let α denote the thermal coefficient of linear expansion of solid substances and β the coefficient of volumetric expansion, then approximately:**
- $\beta \approx \alpha^3$
 - $\beta \approx \alpha/3$
 - $\beta \approx 3/\alpha$
 - $\beta \approx 3 \cdot \alpha$**
30. **For the equilibrium distance r_0 between two atoms (for instance, in a molecule or solid substance):**
- the resultant force is attractive
 - the resultant force is repulsive
 - the resultant force is zero**
 - the character of the resultant force cannot be clearly determined

31. **Why does a liquid cool down during evaporation?**
- a) **the evaporating liquid takes a portion of energy from the rest of the liquid**
 - b) **during evaporation, a portion of the liquid's energy is used up as latent heat of vaporisation**
 - c) during evaporation, a portion of the liquid's energy is used up as latent heat of fusion
 - d) **during evaporation, a portion of the liquid's energy is transferred to particles to overcome the surface tension**
32. **Sublimation is the transition:**
- a) from the gaseous state to the liquid state
 - b) from the gaseous state to the solid state
 - c) **from the solid state to the gaseous state**
 - d) from the liquid state to the gaseous state
33. **Melting is the transition:**
- a) **from the solid state to the liquid state**
 - b) from the liquid state to the solid state
 - c) during which the substance releases energy
 - d) from the liquid state to the gaseous state
34. **A body is floating in water. Assume that the coefficient of thermal volumetric expansion of the body is greater than the coefficient of thermal volumetric expansion of water. What will happen to the position of the body in the water if we heat both the body and the water by the same temperature difference?**
- a) **the body will float higher**
 - b) the body will continue to float
 - c) the body will sink to the bottom
 - d) the position of the body will not change
 - e) the substance releases energy
35. **The decibel (dB) is a unit of:**
- a) velocity of sound propagation
 - b) **sound intensity level**
 - c) pitch of a tone
 - d) acoustic power
36. **Mechanical waves with a frequency less than 16 Hz:**
- a) are called ultrasound
 - b) **are called infrasound**
 - c) correspond to the frequency of sound waves during clearly audible speech
 - d) are clearly audible to a healthy ear

37. **Regarding the sound intensity level:**

- a) the threshold of hearing corresponds to a level of $1 \text{ B} = 10 \text{ dB}$
- b) the threshold of hearing corresponds to a level of $0 \text{ B} = 0 \text{ dB}$**
- c) the threshold of pain corresponds to a level of 12 B
- d) the threshold of pain corresponds to a level of 12 dB

38. **Regarding the velocity of sound:**

- a) the velocity of sound in air is greater than that in solid and liquid materials
- b) the velocity of sound in air is less than that in water**
- c) the velocity of sound in air and that in water are equal
- d) the velocity of sound in air is independent of temperature and atmospheric pressure

39. **Identify the correct statements:**

- a) Mechanical waves with frequencies below 16 Hz are called infrasound.**
- b) Mechanical waves with frequencies below 20 kHz are called ultrasound.
- c) Audible sound is a mechanical wave with a frequency range of approximately 16 Hz to 20 kHz .**
- d) The actual frequency range of hearing in humans varies between individuals and with age**

40. **After a stress test, the patient's pulse-rate doubled:**

- a) the period of cardiac activity was doubled
- b) the period of cardiac activity was halved**
- c) the frequency of cardiac activity was doubled**
- d) the frequency of cardiac activity was halved

41. **If an observer approaches a stationary source at a velocity equal to twice the velocity of sound, the observed frequency compared to the frequency emitted by the source is:**

- a) doubled
- b) tripled**
- c) halved
- d) one-third

42. **The velocity of sound in air is approximately:**

- a) $340 \text{ m}\cdot\text{s}^{-1}$**
- b) $3.4 \text{ km}\cdot\text{s}^{-1}$
- c) $3400 \text{ km}\cdot\text{s}^{-1}$
- d) $340 \text{ km}\cdot\text{h}^{-1}$

43. **Due to the Doppler shift, the frequency of received ultrasonic waves is higher when:**

- a) the detector moves towards the source**
- b) the source and the detector move away from each other
- c) the source and the detector move in the same direction and at the same velocity
- d) the source moves towards the detector**

44. **The absolute refractive index is defined as:**

- a) the product of the velocity of light in a vacuum and in a given medium
- b) the ratio of the velocity of light in a vacuum to that in a given medium**
- c) the ratio of the velocity of light in two arbitrary mediums, at the interface of which light refraction occurs
- d) the ratio of the angle of refraction to the angle of incidence

45. **Glasses in which diverging lenses are used to:**

- a) move the final image of the object closer to the eye lens
- b) move the final image of the object further from the eye lens**
- c) correct myopia (short-sightedness)**
- d) correct hyperopia (long-sightedness)

46. **The human eye is the least sensitive to light that is:**

- a) red
- b) yellow-green**
- c) white
- d) black

47. **The critical angle is the angle:**

- a) of incidence, at which the angle of refraction is 0°
- b) of reflection, corresponding to an angle of incidence of 90°
- c) of incidence, at which total reflection occurs, which can happen when the beam travels from a medium with a higher light velocity to a medium with a lower light velocity
- d) of incidence, at which the angle of refraction is 90° , which can happen when the beam travels from a medium with a lower light velocity to a medium with a higher light velocity**

48. **The image created by the objective lens of an optical microscope is:**

- a) real
- b) observed through the eyepiece**
- c) magnified**
- d) upright

49. **The optical interval of a microscope refers to:**

- a) the distance from the objective lens to the eyepiece
- b) the distance from the focal point of the eyepiece to the focal point of the objective lens**
- c) the length by which the microscope's tube can be moved
- d) the length of the microscope

50. **The approximate velocity of light in a vacuum is:**

- a) $340 \text{ m} \cdot \text{s}^{-1}$
- b) $3 \cdot 10^8 \text{ km} \cdot \text{s}^{-1}$
- c) $3 \cdot 10^8 \text{ km} \cdot \text{h}^{-1}$
- d) **$3 \cdot 10^8 \text{ m} \cdot \text{s}^{-1}$**

51. **The resolving power of a microscope:**

- a) depends only on the intensity of illumination
- b) **is defined as the distance between two points that the observer can still distinguish**
- c) cannot be changed by replacing the eyepiece
- d) does not change when swapping the objective and eyepiece

52. **The velocity of light propagation in water is:**

- a) **dependent on frequency**
- b) greater than in air
- c) **less than in a vacuum**
- d) **dependent on the colour of light**

53. **A large current flows through a diode only when the diode's anode is:**

- a) connected to the negative pole = reverse direction
- b) **connected to the positive pole = forward direction**
- c) connected to the positive pole = reverse direction
- d) connected to the negative pole = forward direction

54. **Electromagnetic radiation is:**

- a) longitudinal wave of vectors E and B
- b) **transverse wave of vectors E and B , which are mutually perpendicular**
- c) transverse wave of vectors E and B , which are mutually parallel
- d) longitudinal wave of vectors E and B , which are mutually perpendicular and phase shifted by $\pi/2$

55. **An electron in a homogeneous electric field moves:**

- a) along a circular path
- b) **generally along a parabola**
- c) at a constant speed
- d) in such a way that it is accelerated against the direction of the intensity of the electric field

56. **Electronvolt (eV) is a secondary unit of:**

- a) **energy**
- b) electric charge
- c) electric voltage
- d) momentum

57. **Electrons can participate in the conduction of electric current as free carriers of electric charge in:**
- a) electrolytes
 - b) metals**
 - c) ionized gases
 - d) semiconductors
58. **The binding energy of a chemical bond:**
- a) indicates the amount of energy needed to break the bond**
 - b) indicates the number of bonds between atoms
 - c) characterizes the strength of the bond**
 - d) can be expressed in electron volts**
59. **Induced voltage:**
- a) is completely independent of the change in the magnetic flux
 - b) does not depend on the rate of change of the magnetic flux
 - c) is higher the slower the rate of change in the magnetic flux
 - d) is higher the rate of change in the magnetic flux**
60. **The magnitude of an alternating current circuit with inductance:**
- a) is linearly dependent on the inductance of the coil and the frequency of the alternating current**
 - b) does not depend on the frequency of the alternating current
 - c) is directly proportional to the inductance of the coil and inversely proportional to the frequency of the alternating current
 - d) is quadratically proportional to the inductance of the coil and directly proportional to the frequency of the alternating current
61. **If the diode is connected in the forward direction, then:**
- a) it has superconductor properties
 - b) its resistance is high and a large current flows through it
 - c) its resistance is low and a large current flows through it**
 - d) its resistance is high and only a negligible current flows through it
62. **If a semiconductor diode is connected in the reverse direction:**
- a) the negative pole is connected to the anode and the positive pole to the cathode**
 - b) only a negligible current flows through it**
 - c) its resistance is almost zero
 - d) its resistance is high**

63. **The magnitude of an alternating current circuit with capacitance is:**
- a) independent of the capacitance of the capacitor and the frequency of the alternating current
 - b) inversely proportional to the capacitance of the capacitor and directly proportional to the frequency of the alternating current
 - c) directly proportional to the capacitance of the capacitor and the frequency of the alternating current
 - d) inversely proportional to the capacitance of the capacitor and the frequency of the alternating current**
64. **A magnetic field is characterized by a vector quantity called:**
- a) the permeability of the medium
 - b) magnetic induction**
 - c) the mass of the iron core of the coil
 - d) relative permeability
65. **The specific conductivity of electrolytes:**
- a) expresses their ability to conduct electrical current**
 - b) depends on concentration**
 - c) depends on temperature**
 - d) is substantially lower than that of metallic conductors**
66. **A charged particle is released with zero velocity in a homogeneous magnetic field; the particle:**
- a) begins to move with uniform acceleration
 - b) begins to move in a direction parallel to the field lines
 - c) begins to move in a direction perpendicular to the field lines
 - d) remains at rest**
67. **A moving charged particle enters a homogeneous electric field with a vector of intensity perpendicular to the direction of motion:**
- a) the direction of the particle's motion changes, but not the magnitude of its velocity
 - b) the magnitude of the particle's velocity changes, but not the direction of its motion
 - c) the path changes to a circular one
 - d) the path changes to a parabolic one**
68. **A variable magnetic field is the cause of an electric field. This phenomenon is called:**
- a) electromagnetic induction**
 - b) Doppler effect
 - c) electrolysis
 - d) polarization

69. Which of the following is NOT correct:

- a) the unit of magnetic flux is 1 Wb
- b) the unit of specific heat capacity is $1 \text{ J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1}$
- c) the unit of frequency is 1 Hz
- d) the unit of power is 1 kWh**

70. Polarization of a dielectric means:

- a) the movement of its particles towards oppositely charged electrodes
- b) the orientation of electric dipoles from atoms or molecules**
- c) the removal of electrons from the dielectric
- d) the creation of an internal electric field of the dielectric**

71. For alternating current in a circuit with resistive load:

- a) Ohm's law does not apply
- b) Ohm's law applies**
- c) Ohm's law applies, but only for small currents ($I < 1 \text{ mA}$)
- d) Ohm's law applies, but only for large resistances ($R > 10^4 \Omega$)

72. The reason that the oscillation of an *RLC* oscillatory circuit is damped is:

- a) non-zero capacitance and inductance of the oscillatory circuit
- b) non-zero inductance of the oscillatory circuit
- c) non-zero capacitance of the inductive circuit
- d) non-zero resistance of the oscillatory circuit**

73. Which physical principles are correct for the devices listed below?

- a) galvanic cell – conversion of chemical energy to electrical energy**
- b) thermistor – dependence of semiconductor electrical resistance on temperature**
- c) resistance thermometer – difference in thermal expansion between two metals
- d) semiconductor diode – one PN junction**

74. In a cyclotron (particle accelerator), the trajectory of moving particles in an external magnetic field is curved into a circle due to the action of the magnetic Lorentz force. This means that:

- a) electrons curve in the opposite direction to protons**
- b) neutrons cannot be accelerated in a cyclotron**
- c) greater magnetic induction causes greater curvature of the path**
- d) the higher the velocity of the particles, the greater the force with which they are deflected**

75. In ionized gases, the following can participate in current conduction:

- a) only positively and negatively charged ions
- b) only electrons
- c) neutrons
- d) electrons, both positively and negatively charged ions**

76. In a changing magnetic field, the vector of magnetic induction:
- changes over time
 - always cancels out
 - does not change
 - does not change over time
77. In an alternating current circuit with angular frequency ω and inductance L , the relationship for inductance X_L is given by:
- $X_L = L \cdot \omega^2/2$
 - $X_L = 1/(\omega \cdot L)$
 - $X_L = L/\omega$
 - $X_L = \omega \cdot L$
78. If we connect a diode to an alternating current circuit so that the diode works as a half-wave rectifier, then:
- the output voltage is alternating and pulsating, and alternating current flows through the circuit
 - the output voltage is direct and pulsating, and direct current flows through the circuit**
 - the output voltage is direct and constant
 - the output voltage is alternating
79. ω is the angular frequency of the source of a harmonic signal to which an oscillator is connected, and ω_0 is the angular frequency of the natural oscillation of the oscillator. Resonance occurs when the following condition is met:
- $\omega \gg \omega_0$
 - $\omega = \omega_0$**
 - $\omega = 10 \cdot \omega_0$
 - $\omega \ll \omega_0$
80. The more optically dense the medium:
- the higher the frequency of the wave passing through the medium
 - the higher the wave velocity
 - the lower its refractive index
 - the higher its refractive index**
81. Isotropic substances:
- have a different velocity of light propagation in different directions
 - have the same velocity of light propagation in all directions**
 - rotate the plane of polarised light
 - are poor conductors of heat

82. **One type of cells found in the eye is called rods. These cells:**

- a) **are located on the retina**
- b) **enable black and white vision**
- c) enable colour vision
- d) are located in the eye lens

83. **Electromagnetic radiation includes:**

- a) ultrasound
- b) **ultraviolet radiation**
- c) **X-ray radiation**
- d) **gamma radiation**

84. **The light that most closely resembles monochromatic light is emitted by:**

- a) incandescent bulbs
- b) fluorescent lamps
- c) the sun
- d) **lasers**

85. **Optically active substances:**

- a) reflect all incident light
- b) have the ability to create optical radiation
- c) absorb all light incident on them
- d) **have the ability to rotate the plane of oscillation of polarised light**

86. **For the wavelength λ of electromagnetic radiation, the following applies (c is the velocity of light and f is the frequency of the radiation):**

- a) $\lambda = f/c$
- b) **$\lambda = c/f$**
- c) $\lambda = c \cdot f$
- d) $\lambda = 1/(c \cdot f)$

87. **When passing through the interface of optical mediums:**

- a) the frequency of the light changes
- b) the velocity of the light does not change
- c) **the frequency of the light does not change, but the velocity of light propagation does change**
- d) the wavelength of the light does not change

88. Light is a:

- a) transverse mechanical wave (in solid substances)
- b) transverse electromagnetic wave**
- c) longitudinal electromagnetic wave
- d) stream of photons**

89. Ultraviolet radiation:

- a) has a higher frequency than visible light**
- b) has shorter wavelengths than visible light**
- c) has shorter wavelengths than X-ray radiation
- d) has a higher frequency than infrared radiation**

90. A perfect black body:

- a) reflects and radiates
- b) reflects perfectly
- c) only absorbs
- d) absorbs and radiates**

91. Absorption of electromagnetic radiation:

- a) is a process in which incoming photons are absorbed by matter and cause atoms to transition to a higher energy state**
- b) always causes the release of an electron from the atom
- c) leads to the absorption of electrons from the shell by the atomic nucleus
- d) means the process of releasing energy from atoms in the form of photons

92. The activity of a radioactive sample:

- a) is the number of nuclei that transform in 1 second**
- b) decreases exponentially with time**
- c) decreases logarithmically with time
- d) has the same physical unit as the half-life

93. Two isotopes of the same element have a different number of:

- a) protons
- b) neutrons**
- c) nucleons**
- d) electrons

94. **An excited state of an atom refers to:**

- a) a state where the atom has accepted an electron from another atom
- b) a state where the atom has released at least one electron
- c) a state with higher energy values of the electrons in the shell than in the ground state**
- d) a state with a higher number of nucleons in the nucleus

95. **Gamma radiation:**

- a) is electromagnetic radiation**
- b) is a stream of neutrons
- c) is a stream of photons**
- d) is not deflected by an electric field**

96. **The nucleus of carbon $^{12}_6\text{C}$ contains:**

- a) 6 neutrons**
- b) 6 nucleons
- c) 12 protons
- d) 12 electrons

97. **During radioactive decay, the number of radioactive atoms in the sample decreases over time approximately:**

- a) linearly
- b) exponentially**
- c) logarithmically
- d) in an inverse square way

98. **The dimensions of an atom are on the order of:**

- a) 1 pm
- b) 0.1 μm
- c) 100 nm
- d) 100 pm**

99. **Alpha radiation:**

- a) consists of helium nuclei**
- b) is attracted to a negatively charged electrode**
- c) contains fast electrons
- d) contains free fast protons and neutrons

100. **Beta radiation consists of:**

- a) protons
- b) electrons**
- c) photons
- d) helium nuclei

Biology

1. **Gamete is a general term for:**

- a) germ cell**
- b) sex chromosome
- c) a cell formed by the fusion of sex cells
- d) gonad

2. **An example of asexual reproduction is:**

- a) mitotic division in unicellular organisms**
- b) budding in hydra**
- c) reproduction of plants by cuttings**
- d) strobilation in jellyfish**

3. **Ethology is a branch of science that studies:**

- a) the movements of plants
- b) the systematics and phylogeny of insects
- c) the behaviour of animals**
- d) the relationships between organisms and environmental factors

4. **An enzyme is:**

- a) synonym for any protein
- b) any protein of yeast origin
- c) protein catalyst of metabolic processes**
- d) non-protein coenzyme activator

5. **Chlorophyll:**

- a) is present exclusively in plant mitochondria
- b) is mostly freely dissolved in the cytoplasm of plant cells
- c) is present in chloroplasts**
- d) contains a magnesium atom in its molecule**

6. **The current central dogma of molecular biology postulates the flow of genetic information:**

- a) from DNA to DNA during replication**
- b) from proteins to DNA
- c) from proteins to polysaccharides
- d) from DNA to RNA**

7. **Circular DNA molecules can be present:**
- a) in bacterial cells
 - b) in some viruses
 - c) in chloroplasts
 - d) in mitochondria
8. **The introduction of foreign DNA into a bacterial cell using a bacteriophage is called:**
- a) translocation
 - b) conjugation
 - c) transcription
 - d) **transduction**
9. **The polypeptide strand of a bacterial protein consists of 202 amino acids. What will be the length of the respective coding sequence of the respective mRNA (without the STOP codon)?**
- a) 202 nucleotides
 - b) 303 nucleotides
 - c) **606 nucleotides**
 - d) 101 nucleotides
10. **Which of these molecules is/are directly involved in the translation process?**
- a) **tRNA**
 - b) hnRNA
 - c) **mRNA**
 - d) DNA polymerase
11. **Exons:**
- a) **are sections of the gene present in mature mRNA**
 - b) are sections of the gene that are not replicated
 - c) are sections of the gene that do not participate in translation
 - d) are non-coding genomic sequences that are not part of genes
12. **The DNA molecules responsible for extranuclear inheritance are present:**
- a) in the nucleus
 - b) **in mitochondria**
 - c) **in chloroplasts**
 - d) in ribosomes
13. **Ames test:**
- a) **determines the mutagenicity of chemical substances using special strains of bacteria**
 - b) **is based on the induction of gene mutations in bacteria**
 - c) detects chromosome mutations in mammalian cells after application of the test substance
 - d) evaluates the genotoxicity of chemical substances using studies of genetic disorders in exposed human populations

14. **What is a codon? (Do not consider STOP codons)**
- a) a triplet of nucleotides in tRNA that determines the addition of one amino acid to the polypeptide strand
 - b) a triplet of nucleotides in rRNA that determines the attachment site of tRNA to the ribosome
 - c) a triplet of nucleotides in mRNA that determines the addition of one amino acid to the polypeptide chain**
 - d) a triplet of nucleotides in mRNA, to which a certain tRNA attaches with its complementary anticodon
15. **Choose the correct statement(s) about proteins:**
- a) a polypeptide strand is composed mainly of nucleotides
 - b) the primary structure of proteins has the character of an α -helix or a β -pleated sheet
 - c) hydrogen bonds are also involved in the formation of the secondary structure of proteins**
 - d) the primary structure of proteins is determined by the sequence of amino acids**
16. **The so-called initiation (START) codon:**
- a) is part of the promoter and indicates the beginning of transcription
 - b) does not code for any amino acid
 - c) in eukaryotes, it codes for methionine during translation**
 - d) indicates the beginning of DNA replication
17. **How many different codon variants can we find in mRNA molecules?**
- a) 20
 - b) 22
 - c) 64**
 - d) 96
18. **Which of the following amino acids contain(s) sulphur in its molecule?**
- a) glycine
 - b) methionine**
 - c) valine
 - d) cysteine**
19. **In retroviruses, which molecule is the template for viral DNA synthesis?**
- a) a specific protein called a prion
 - b) DNA
 - c) a specific retroprotein
 - d) RNA**
20. **A technique called DNA-fingerprinting:**
- a) is mainly used for direct diagnosis of mutations in monogenic diseases
 - b) is a special technique that allows the isolation of DNA from fingerprints
 - c) enables the identification of persons in forensic medicine**
 - d) is also used in paternity testing**

21. **The breaking of hydrogen bonds between bases in complementary strands of DNA molecules is called:**
- a) DNA annihilation
 - b) DNA diffraction
 - c) DNA denaturation**
 - d) DNA reassociation
22. **Frameshift mutations can be caused by:**
- a) insertion of one nucleotide**
 - b) deletion of one nucleotide**
 - c) substitution of one nucleotide for another nucleotide
 - d) deletion of two consecutive nucleotides**
23. **Choose the correct statement(s) about codon:**
- a) a codon consists of three nucleotides**
 - b) one codon usually codes for 2-4 different amino acids
 - c) the codon is located at one end of the tRNA molecule (the so-called codon arm)
 - d) a codon is the basic unit of the genetic code**
24. **The technique referred to as PCR:**
- a) serves to cleave DNA using restriction endonucleases
 - b) is called polymerase chain reaction**
 - c) enables the amplification of a selected DNA sequence**
 - d) usually uses a thermostable DNA polymerase**
25. **Which enzyme connects ribonucleotides during RNA synthesis?**
- a) RNA transcriptase
 - b) RNA polymerase**
 - c) RNA nuclease
 - d) reverse transcriptase
26. **The share of cytosine (C) among bases in the chromosomal DNA of a certain mammal is 30%. What are the percentages of the other bases?**
- a) adenine (A) 20%, thymine (T) 20%, guanine (G) 30%**
 - b) adenine (A) 20%, thymine (T) 30%, guanine (G) 20%
 - c) guanine (G) 30%, the proportion of adenine (A) and thymine (T) cannot be clearly determined
 - d) adenine (A) 30%, thymine (T) 20%, guanine (G) 20%
27. **Genetic code:**
- a) is significantly different in prokaryotic and eukaryotic organisms
 - b) has changed considerably during recent evolution
 - c) is defined as the collection of all DNA molecules in an organism
 - d) is universal**

28. **Unlike eukaryotic cells, prokaryotic cells never contain:**
- a) cell wall
 - b) ribosomes
 - c) **mitochondria**
 - d) chloroplasts
29. **A bacteriophage is:**
- a) **a virus that attacks bacterial cells**
 - b) a special bacterium that engulfs bacterial viruses
 - c) a large, membrane-enveloped bacterium-like virus that attacks animal cells
 - d) an immune system cell (a type of macrophage) that engulfs bacteria
30. **Select a group of human diseases that includes only viral infections:**
- a) **infectious jaundice (hepatitis A), AIDS, measles, chicken pox**
 - b) chicken pox, syphilis, infectious jaundice (hepatitis A), polio
 - c) inflammation of the meninges, variant Creutzfeldt-Jakob disease, mumps, influenza
 - d) tuberculosis, inflammation of the meninges, measles, infectious jaundice (hepatitis A)
31. **A prion is:**
- a) **a protein infectious particle**
 - b) the immature stage of the virus
 - c) the protein component of the viral particle
 - d) an infectious RNA molecule formerly referred to as a viroid
32. **A particle called a virion can contain:**
- a) **capsid**
 - b) **RNA molecule**
 - c) **DNA molecule**
 - d) **membrane envelope**
33. **Peptidoglycan:**
- a) is a protein forming the envelope of virions
 - b) is an artificial dye used for microscopic identification of glycoproteins in bacterial cells
 - c) is a basic component of the media on which bacteria are cultivated in the laboratory
 - d) **is the basic component of the cell wall of most bacteria**
34. **What happens during bacterial conjugation?**
- a) the joining of two cells and the two-way mutual exchange of their chromosomes
 - b) **the joining of two cells, whereby part of the genetic information passes from one cell to the other one**
 - c) the complete fusion of two cells and their chromosomes leading to the formation of one daughter cell
 - d) the fusion of two cells, whereby their chromosomes form a homologous pair

35. **Which substances are produced during photosynthesis? (Consider the typical course of photosynthesis in a green plant.)**
- a) oxygen and carbon dioxide
 - b) carbon dioxide and water
 - c) oxygen, water and carbohydrates**
 - d) carbon dioxide, water and carbohydrates
36. **Which of these plants are classified as dicotyledonous plants?**
- a) sunflower (*Helianthus*)**
 - b) iris (*Iris*)
 - c) rose (*Rosa*)**
 - d) pea (*Pisum*)**
37. **Toxoplasma (*Toxoplasma gondii*):**
- a) is a bacterium producing toxic substances (especially botulinum toxin)
 - b) belongs to the parasites that also attack humans**
 - c) causes the so-called sleeping sickness
 - d) if it infects a pregnant woman, it can cause serious inborn defects in the newborn**
38. **In chordates:**
- a) the chorda dorsalis is formed from the neural tube
 - b) the chorda dorsalis arises from the ectoderm
 - c) the chorda dorsalis arises from the chordamesoderm**
 - d) the neural tube is formed together with the dorsal chord (chorda dorsalis) by shedding the endoderm
39. **The crustaceans (Crustacea) do not include:**
- a) krill (*Euphausiacea*)
 - b) copepods (*Copepoda*)
 - c) spiders (*Aranae*)**
 - d) scorpions (*Scorpiones*)**
40. **Trichomoniasis is most commonly transmitted by:**
- a) Anopheles mosquito
 - b) ticks
 - c) sexual intercourse**
 - d) infected rodents or rabbits
41. **Cetaceans include:**
- a) dolphin**
 - b) sperm whale**
 - c) sea lion
 - d) walrus

42. **Protists from the genus Plasmodium are the causative agents of which human disease?**
- a) sleeping sickness
 - b) bloody diarrhoea
 - c) haemophilia
 - d) malaria**
43. **Which group(s) of organisms has/have the prokaryotic cell type:**
- a) protists
 - b) archaea**
 - c) eubacteria**
 - d) cyanobacteria**
44. **Plasma membrane:**
- a) is a single layer of phospholipid molecules
 - b) is a double layer of phospholipid molecules**
 - c) contains transport proteins**
 - d) is engaged in endocytosis**
45. **Mitochondria:**
- a) have no ribosomes
 - b) have their own ribosomes different from the ribosomes in the cytoplasm of the cell**
 - c) have the same ribosomes as in the cytoplasm of the cell
 - d) have some of their own specific ribosomes and some the same as those in the cell cytoplasm
46. **Telomere is:**
- a) the end of a linear chromosome in eukaryotic organisms**
 - b) the central region of the chromosome where sister chromatids meet
 - c) the final phase of mitosis
 - d) a cellular structure composed of microtubules that participates in mitosis
47. **Zygote:**
- a) is a male or female gamete
 - b) is formed by the union of sex cells**
 - c) is a fertilized egg**
 - d) is the eight-cell stage of the furrowing embryo
48. **A human haploid cell contains:**
- a) 23 chromosomes**
 - b) 22 chromosomes
 - c) 46 chromosomes
 - d) always both sex chromosomes X and Y

49. **During meiosis, the following occurs:**
- a) **the reduction of the number of chromosomes in the nuclei of cells**
 - b) the increase of the number of chromosomes in the nuclei of cells
 - c) **the segregation of chromosomes into gametes**
 - d) **the crossing-over**
50. **Polar body (polocyte):**
- e) arises during spermatogenesis
 - a) is a diploid cell that arises at the end of oogenesis
 - b) is the terminal part of the sperm head
 - c) **is a haploid cell that arises during oogenesis**
51. **Prenatal examination of the cells of a human foetus revealed that each of them contains 47 chromosomes. What is the name for this chromosomal aberration?**
- a) monosomy
 - b) diploidy
 - c) triploidy
 - d) **trisomy**
52. **Submetacentric chromosome:**
- a) has the same length of p- and q-arm
 - b) **has a p-arm shorter than a q-arm**
 - c) **is a type of chromosome that is also found in the human karyotype**
 - d) is a general term for a very small chromosome that cannot be observed with an optical microscope
53. **Extranuclear inheritance in humans:**
- a) **is manifested by matrocliny**
 - b) is heredity linked to ribosomes, or ribosomal DNA
 - c) manifests itself in all organisms in such a way that the offspring must always have the same phenotypic traits as the mother
 - d) **is mitochondrial and plastid inheritance**
54. **If a haemophilia A carrier has children with a healthy man, the children will be:**
- a) half of daughters affected, half of sons affected
 - b) **half of daughters carriers, half of sons affected**
 - c) **all daughters non-carriers, half of sons affected**
 - d) all daughters and sons affected
55. **Two sons with haemophilia A, one healthy son and one healthy daughter were born to healthy parents. What are the genotypes of these family members?**
- a) **the mother is a carrier**
 - b) **the daughter can be a carrier or a non-carrier**
 - c) **both affected sons are hemizygotes carrying the haemophilia allele**
 - d) the father is a carrier, the mother has a normal genotype

56. **Traits with multifactorial inheritance are affected by:**
- a) additive effect of alleles
 - b) interaction of genotype and environment**
 - c) interaction of a larger number of genes
 - d) environmental influences
57. **A son affected by an autosomal dominant hereditary disease with full penetrance was born to completely healthy parents. What is a possible explanation?**
- a) both parents are heterozygotes, and the child is a dominant homozygote
 - b) non-paternity must have occurred in the family
 - c) the son's disease arose due to *de novo* mutation**
 - d) the mother is a carrier of the mutant allele, while the father is not
58. **Genealogy:**
- a) includes pedigree analysis
 - b) is a necessary part of the clinical genetic examination**
 - c) consists, among other things, of filling in a pedigree questionnaire by the proband (propositus, index patient) or their relatives**
 - d) is the calculation of the gene linkage strength in centimorgans (cM)
59. **Which trait(s) can have monogenic inheritance in humans:**
- a) body height
 - b) colour blindness (daltonism)**
 - c) intelligence
 - d) all autoimmune diseases
60. **The sex chromosome Y is found in humans:**
- a) in half of sperm cells and half of male somatic cells
 - b) in half of sperm cells and in all male somatic cells**
 - c) in all sperm and in all somatic male cells
 - d) in all sperm and in half of male somatic cells
61. **Choose the correct statement (or statements) about phenylketonuria:**
- a) it is an autosomal recessive disease**
 - b) it is a severe type of diabetes, in which a high concentration of phenols and ketones (especially acetone) accumulates in the patient's urine
 - c) if phenylketonuria is already detected in a newborn, the onset of its serious manifestations can be prevented with a suitable diet**
 - d) it is a disorder of the metabolic conversion of phenylalanine**

62. **The population consists of:**
- a) only those individuals of the same species that have a completely identical genotype
 - b) all individuals of the same species that live in a certain habitat and can interbreed**
 - c) organisms of different species that live in the same habitat and create an ecosystem
 - d) all individuals that belong to one species and live in different, often very distant habitats
63. **Alleles of one gene:**
- a) may differ in terms of phenotypic expression**
 - b) occur at the same locus**
 - c) may not be the same**
 - d) may be responsible for the emergence of a certain character**
64. **Genome:**
- a) is the set of all genes in a cell, or in the organism (without non-coding sequences)
 - b) is a set of all DNA molecules in a cell, or in the organism**
 - c) is a synonym for genotype
 - d) is significantly influenced by phenotype
65. **Blood groups of the ABO system are inherited:**
- a) as a monogenic trait, with significant participation of external environmental factors
 - b) as a polygenic trait, without the participation of the external environment
 - c) as a monogenic trait, without the participation of external environmental factors**
 - d) as a multifactorial trait
66. **Alternative forms of genes at the same loci on homologous chromosomes are called:**
- a) mutagens
 - b) alleles**
 - c) pseudomorphisms
 - d) pseudogenes
67. **The set of alleles of a given individual is called (choose the most accurate term):**
- a) genome
 - b) genotype**
 - c) gene pool
 - d) karyotype
68. **In an ideal panmictic population, whose members reproduce exclusively sexually, the frequency of dominant homozygotes is 0.01. Based on the Hardy-Weinberg equilibrium, determine the frequency of recessive homozygotes:**
- a) 0.5
 - b) 0.18
 - c) 0.81**
 - d) 0.99

69. In humans and fruit flies (*Drosophila*), the female sex is:
- a) heterozygous
 - b) homogametic**
 - c) heterogametic
 - d) autosomal
70. The Hardy-Weinberg equilibrium in the population is NOT disturbed by:
- a) sufficient population size**
 - b) mutation
 - c) genetic drift
 - d) panmixia**
71. Mother has blood type B, Rh+, father has A, Rh-. Their child:
- a) can have blood groups O, Rh+**
 - b) cannot have blood groups AB, Rh-
 - c) can have all blood types in both systems**
 - d) cannot have blood groups O, Rh+
72. Deoxygenated blood is found in humans:
- a) in all veins
 - b) in the pulmonary veins
 - c) in the pulmonary arteries**
 - d) in the right atrium**
73. The colour vision is enabled by
- a) rod cells
 - b) optic disc (blind spot)
 - c) vitreous body
 - d) cone cells**
74. Axon is:
- a) a long projection of a neuron**
 - b) the opposite of an intron
 - c) a translated part of the gene
 - d) a gene located in the axis of the chromosome
75. For an eye defect called short-sightedness (myopia):
- a) the biconcave lenses are used for the correction**
 - b) the biconvex lenses are used for the correction
 - c) the image of more distant objects appears in front of the retina**
 - d) nearby objects appear behind the retina

76. **Haematocrit is:**

- a) blood dye in human erythrocytes
- b) a general designation for any pathological condition where haematopoiesis is critically reduced
- c) a device for automatic blood analysis
- d) a value that indicates the proportion of red blood cells in the total volume of blood**

77. **What is the frequency of a tone that produces a sound sensation in the human ear?**

- a) 50 mHz
- b) 50 Hz**
- c) 50 kHz
- d) 50 MHz

78. **Cyanosis:**

- a) is a rare genetic disease in which cyanide accumulates in the body
- b) is a designation for noticeably flushed to red skin, which indicates good blood circulation and high oxygen saturation of the blood
- c) can occur with carbon monoxide intoxication**
- d) is a sign for bluish to blue discoloration of the skin and mucous membranes**

79. **Female sex hormones are mainly formed:**

- a) in the ovaries**
- b) in the pituitary gland (hypophysis cerebri)
- c) in the womb
- d) in the vagina

80. **A nephron consists of:**

- a) Bowman's capsule, glomerulus, proximal tubule, loop of Henle, distal tubule and collecting ducts
- b) Bowman's capsule, glomerulus, proximal tubule, loop of Henle and distal tubule**
- c) the glomerulus only
- d) Bowman's capsule and glomerulus

81. **Trypsinogen is produced by:**

- a) liver
- b) gastric mucosa
- c) pancreas**
- d) mucosa of the small intestine

82. **After surgical removal of the gallbladder, the patient must be especially careful in taking:**

- a) proteins
- b) fibre
- c) sugars
- d) fats**

83. Which of the listed male organs is common to the urinary and reproductive systems?

- a) testicles
- b) urethra**
- c) ureter
- d) prostate

84. Which of the listed tissues mostly forms the inner lining of organs?

- a) epithelial tissue**
- b) connective tissue
- c) nervous tissue
- d) muscle tissue

85. Control of breathing movements:

- a) is affected by changes in the concentration of CO₂ and O₂ in the blood
- b) takes place through the respiratory centre in the medulla oblongata**
- c) takes place through chemoreceptors in the aorta and carotid arteries
- d) is influenced by the central nervous system

86. Bile:

- a) is produced in the gallbladder
- b) facilitates the digestion of fats**
- c) contains bile pigments, cholesterol and mucus
- d) is created in the liver

87. The production of thyroid hormones is mainly dependent on the intake of:

- a) iron
- b) copper
- c) potassium
- d) iodine**

88. Long-term insufficient intake of vitamin D to the human body causes:

- a) formation of a goitre (also goitre)
- b) scurvy
- c) rickets**
- d) a disease called beriberi

89. Human red blood cells:

- a) do not have a nucleus**
- b) contain haemoglobin**
- c) are not capable of independent movement**
- d) their numbers are higher in the blood of women compared to the blood of men

90. Which cells are responsible for the cellular immune reaction (e.g. against transplants)?
- a) B lymphocytes
 - b) platelets
 - c) all types of leukocytes
 - d) T lymphocytes**
91. Cancerous diseases include:
- a) leukaemia**
 - b) lymphomas**
 - c) carcinomas**
 - d) sarcomas**
92. Typical autoimmune diseases is/are:
- a) leukaemia
 - b) allergic asthma
 - c) Lyme disease
 - d) multiple sclerosis**
93. The first mammals appeared:
- a) at the beginning of the Quaternary
 - b) at the beginning of the Paleozoic during the so-called Cambrian radiation
 - c) at the beginning of the Mesozoic**
 - d) at the beginning of the Tertiary
94. Results of the study of mitochondrial DNA in different human populations:
- a) prove that the modern man (Homo sapiens) arose independently in several places on Earth
 - b) testifies to the so-called monocentric theory, according to which modern Homo sapiens most likely originated in Africa**
 - c) proves that the human species (Homo sapiens) originated in Central Europe
 - d) testifies to the fact that modern Homo sapiens arose in Australia from Australopithecus
95. According to evolutionary theories based on Darwinism, what is the role of natural selection?
- a) natural selection causes that individuals with lower fitness also have a lower chance of producing offspring**
 - b) natural selection reproductively favours individuals whose genotype allows them to survive in given environmental conditions**
 - c) the mechanisms of natural selection directly cause favourable mutations in some individuals and thus enable the improvement of their reproductive abilities
 - d) natural selection acts only in small populations and increases their size

96. Which of the listed mammals is phylogenetically most closely related to humans?
- macaque
 - gorilla
 - chimpanzee**
 - orangutan
97. The term biome refers to:
- a set of individuals of one species that have the same genome
 - the sum of all living organisms forming the biosphere on Earth
 - a set of geographically delineated ecosystems with common features**
 - the cycle of a certain biogenic element
98. Eutrophication of water in lakes occurs most often:
- as a result of an increase in the concentration of inorganic nutrients (nitrates, phosphates etc.)**
 - as a result of acid rain, when the toxic effects of sulphur dioxide are manifested
 - as a result of the supply of toxic metals from chemical plants or ore mines
 - due to excessive fertilization of agricultural land**
99. Louis Pasteur:
- was the first researcher to accurately describe mitotic cell division
 - performed vaccination against rabies for the first time**
 - developed vaccination against anthrax**
 - disproved the theory of spontaneous generation (abiogenesis) with his experiments**
100. The Human Genome Project (HGP) was officially launched:
- at the beginning of the 20th century after the rediscovery of Mendel's laws
 - in 1953 after the discovery of the double helix structure of DNA
 - at the beginning of the 1940s in connection with research into the possible mutagenic effects of chemical warfare agents
 - in the year 1990**

Chemistry

- The principal quantum number n :
 - indicates the number of electrons
 - determines whether the electron belongs to one of the seven energy levels**
 - determines the relative position of the orbitals in space
 - characterizes the rotational movement of electrons
- The atom is fully characterized by:
 - its atomic and nucleon number**
 - its proton number
 - its nucleon number
 - its neutron number

3. **Isotopes of the same element are nuclides that:**
- a) differ in the charge of the nucleus
 - b) differ in nucleon number**
 - c) differ only in atomic number
 - d) have the same proton number**
4. **Alpha radiation is:**
- a) a stream of positrons
 - b) a stream of electrons
 - c) a stream of photons
 - d) a stream of helium nuclei**
5. **The group of alkali metals includes:**
- a) Sr
 - b) Sc
 - c) Cs**
 - d) Be
6. **The group of halogens does not include:**
- a) F
 - b) Cl
 - c) Br
 - d) B**
7. **Which noble gas is the most abundant in the Earth's atmosphere?**
- a) argon**
 - b) helium
 - c) neon
 - d) hydrogen
8. **Choose the element with the highest electronegativity:**
- a) sodium
 - b) oxygen**
 - c) carbon
 - d) aluminum
9. **Anions are easily formed from:**
- a) s elements
 - b) elements with high electron affinity**
 - c) elements with low electron affinity
 - d) elements with low ionization energy

10. Which of the following elements have the same number of valence electrons as nitrogen?

- a) oxygen
- b) phosphorus**
- c) tin
- d) arsenic**

11. The main biogenic macroelements include:

- a) N**
- b) Co
- c) Fe
- d) Cu

12. What atom is bound in the heme molecule?

- a) magnesium
- b) sodium
- c) manganese
- d) iron**

13. Which quantity describes the ability of an atom to attract shared electrons?

- a) activation energy (E_A)
- b) atomic electronegativity (X)**
- c) proton number (Z)
- d) ionization energy (E_i)

14. Which of the following molecule(s) is/ are polar?

- a) CH_4
- b) H_2O**
- c) C_6H_6
- d) HF**

15. In an exothermic reaction, heat is:

- a) absorbed
- b) released**
- c) consumed
- d) does not change

16. What is the importance of a catalyst in a chemical reaction?

- a) it does not affect the reaction rate
- b) reduces the activation energy**
- c) decreases the rate of reaction
- d) increases the activation energy

17. **The equilibrium of precipitation reactions is characterized by:**
- a) pH
 - b) Avogadro's constant
 - c) the ionic product of water
 - d) solubility product**
18. **Heterogeneous dispersion systems include:**
- a) aqueous NaOH solution
 - b) blood**
 - c) milk**
 - d) brass
19. **The hydrogen exponent is defined by:**
- a) $\text{pH} = -\log[\text{H}_3\text{O}^+]$**
 - b) $\text{pH} = -\ln[\text{H}_3\text{O}^+]$
 - c) $\text{pH} = \log[\text{H}_3\text{O}^+]$
 - d) $\text{pOH} = -\log[\text{H}_3\text{O}^+]$
20. **Decide which of the following statement is true for an alkaline environment:**
- a) $[\text{OH}^-] < [\text{H}_3\text{O}^+]$
 - b) $[\text{H}_3\text{O}^+] < [\text{OH}^-]$**
 - c) $[\text{H}_3\text{O}^+] = [\text{OH}^-]$
 - d) $[\text{H}_3\text{O}^+] > [\text{OH}^-]$
21. **Which of the following oxides react with water to form hydroxides?**
- a) SiO_2
 - b) K_2O
 - c) Cl_2O_7**
 - d) CaO**
22. **Which of the following oxides react with water to form oxygen-containing acid?**
- a) CO
 - b) N_2O_5**
 - c) SO_3**
 - d) N_2O
23. **What is/are the product(s) of the reaction of ionic hydrides with water?**
- a) H_3O^+
 - b) Ionic hydrides do not react with water
 - c) H_2**
 - d) O_2

24. The reaction of calcium carbide and water produces calcium hydroxide and:
- a) ethylene
 - b) acetylene**
 - c) ethane
 - d) carbon dioxide
25. What is the formula of the compound formed between Fe^{3+} and Cl^- ions?
- a) FeCl_3**
 - b) FeCl_2
 - c) FeCl
 - d) Fe_2Cl_3
26. $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$ is the formula of:
- a) ammonium chromate
 - b) ammonium dichromate**
 - c) ammonium perchromate
 - d) ammonium peroxochromate
27. Which of the following gases are highly poisonous to humans?
- a) He
 - b) N_2
 - c) Cl_2
 - d) COCl_2**
28. What is the formula of the tetraoxophosphoric acid?
- a) H_3PO_4**
 - b) H_2PO_4
 - c) HPO_4
 - d) $\text{H}_4\text{P}_2\text{O}_7$
29. Which of the following compounds is/are weak electrolyte(s)?
- a) potassium carbonate
 - b) ammonia**
 - c) ammonium chloride
 - d) sodium chloride
30. Which of the following compounds is/are strong acid(s)?
- a) HClO_4**
 - b) H_2CO_3
 - c) HCl
 - d) HCN

31. **What type of reaction is acid base neutralization?**
- a) **protolytic reaction**
 - b) redox reaction
 - c) chemical decomposition
 - d) proteolysis
32. **Which of the following salts will react alkaline in aqueous solution?**
- a) NH_4Cl
 - b) **Na_2CO_3**
 - c) Na_2SO_4
 - d) **Na_2SO_3**
33. **What is the oxidation number of phosphorus in the P_4 molecule?**
- a) **0**
 - b) V
 - c) III
 - d) IV
34. **In an oxidation-reduction reaction, reducing agent undergoes:**
- a) reduction
 - b) neutralization
 - c) **oxidation**
 - d) dissociation
35. **In the reaction $\text{Zn} + 2 \text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$:**
- a) hydrogen cation acts as an oxidizing agent
 - b) zinc acts as an oxidizing agent
 - c) **hydrogen cation is reduced and the zinc is oxidized**
 - d) zinc is reduced and chlorine is oxidized
36. **Reduction can be characterized as:**
- a) hydrogenation
 - b) **acceptance of electron(s)**
 - c) dehydrogenation
 - d) hydration
37. **In the electrolysis of molten KCl , which product forms at the cathode?**
- a) **K**
 - b) O_2
 - c) H_2
 - d) Cl_2

38. Choose the correct statement(s) about electrolysis:

- a) *Anode* is the electrode where reduction takes place.
- b) *Cathode* is the electrode where reduction takes place.**
- c) *Anode* is the electrode where oxidation takes place.
- d) *Cathode* is the electrode where oxidation takes place.

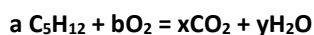
39. Reaction of gas chlorine with aqueous hot sodium hydroxide produces chlorates:



Which of the following contains the correct stoichiometric coefficients?

- a) a = 3, b = 6, x = 1, y = 5, z = 3**
- b) a = 1, b = 1, x = 1, y = 1, z = 1
- c) a = 4, b = 5, x = 3, y = 2, z = 2
- d) a = 2, b = 2, x = 1, y = 1, z = 2

40. Pentane reacts with oxygen to form carbon dioxide and water:



Which of the following contains the correct stoichiometric coefficient for oxygen?

- a) b = 6
- b) b = 4
- c) b = 8**
- d) b = 3

41. Determine the mass of oxygen present in sodium carbonate per 50 grams of sodium:

$$A_r(\text{Na}) = 23, A_r(\text{C}) = 12, A_r(\text{O}) = 16$$

- a) 34.78 grams of oxygen
- b) 52.17 grams of oxygen**
- c) 47.91 grams of oxygen
- d) 104.34 grams of oxygen

42. How many grams of crystal water does 15 grams of blue rock $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ contain?

$$A_r(\text{Cu}) = 64, A_r(\text{S}) = 32, A_r(\text{O}) = 16, A_r(\text{H}) = 1$$

- a) 5.40 g**
- b) 6.70 g
- c) 8.38 g
- d) 5.01 g

43. Determine which of the following compounds has the highest nitrogen percentage:

$$A_r(\text{N}) = 14, A_r(\text{S}) = 32, A_r(\text{Na}) = 23, A_r(\text{O}) = 16, A_r(\text{H}) = 1, A_r(\text{Cl}) = 35$$

- a) ammonium chloride**
- b) sodium nitrite
- c) sodium nitrate
- d) ammonium sulphate

44. What amount of aluminum is contained in 1 mole of aluminum oxide?

- a) 3 mol
- b) 4 mol
- c) **2 mol**
- d) 1 mol

45. Calculate the amount of substance of 10 grams of copper. How many atoms are contained in this amount of copper?

$$A_r(\text{Cu}) = 64$$

- a) **0.156 mol; $9.41 \cdot 10^{22}$ atoms**
- b) 10 mol; $60.23 \cdot 10^{23}$ atoms
- c) 0.156 mol; $9.48 \cdot 10^{-23}$ atoms
- d) $1.56 \cdot 10^{-1}$ mol; $0.941 \cdot 10^{23}$ atoms

46. How many grams of NaOH are contained in 2 dm³ of a solution with substance concentration $c(\text{NaOH}) = 0.05 \text{ mol dm}^{-3}$?

$$A_r(\text{Na}) = 23, A_r(\text{O}) = 16, A_r(\text{H}) = 1$$

- a) **4 g**
- b) 2 g
- c) 40 g
- d) 0.05 g

47. Calculate the molar concentration of NH₄Br, if you know that 1.5 dm³ of this solution contains 147 g of NH₄Br:

$$A_r(\text{N}) = 14, A_r(\text{Br}) = 80, A_r(\text{H}) = 1$$

- a) 1 mmol dm⁻³
- b) 0.1 mmol dm⁻³
- c) 0.1 mol dm⁻³
- d) **1 mol dm⁻³**

48. You know that 0.400 dm³ of a KCl solution contains 12 grams of KCl. Calculate the substance concentration of the KCl in this solution:

$$A_r(\text{K}) = 39, A_r(\text{Cl}) = 35$$

- a) 4.05 mol dm⁻³
- b) 1.61 mol dm⁻³
- c) **0.405 mol dm⁻³**
- d) 0.161 mol dm⁻³

49. Nitrogen dioxide combines with water to form nitric acid and nitric oxide.
The reaction is described by the equation $3 \text{NO}_2 + \text{H}_2\text{O} \rightarrow 2 \text{HNO}_3 + \text{NO}$. Calculate the amount of the HNO_3 substance which can be produced from 0.06 mol of NO_2 :
- a) **0.04 mol**
 - b) 0.06 mol
 - c) 0.02 mol
 - d) 0.03 mol
50. How many grams of sodium hydroxide are needed for the preparation of 350 grams of the solution with mass fraction $w(\text{NaOH}) = 0.08$?
- a) 35 g
 - b) **28 g**
 - c) 8 g
 - d) 16 g
51. We mix 21 g of a 14% sodium iodide solution with a 10% solution of the same compound. How many grams of the 10% solution are needed to give an 11% solution of sodium iodide?
- a) 57.0 g
 - b) **63.0 g**
 - c) 10.0 g
 - d) 8.3 g
52. Calculate the volume of water needed to prepare 0.45 dm^3 of an acetic acid solution if you know that the final volume fraction of acetic acid in that solution is 30%:
- a) **315 cm^3**
 - b) 450 cm^3
 - c) 300 cm^3
 - d) 135 cm^3
53. We mixed 250 grams of nitric acid with mass fraction $w(\text{HNO}_3) = 0.08$ and 90 grams of water. Calculate the mass fraction in % of the nitric acid in this final solution:
- a) 6.45 %
 - b) 4.07 %
 - c) **5.88 %**
 - d) 8.0 %
54. What amount of carbon monoxide occupies a volume of 140 dm^3 under normal conditions?
 $A_r(\text{C}) = 12, A_r(\text{O}) = 16$
- a) 132 grams
 - b) 275 grams
 - c) **175 grams**
 - d) 140 grams

55. Calculate the volume of nitrogen, which is theoretically needed for the preparation of 56 dm³ of ammonia, if the reaction is: $\text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3$:
- $A_r(\text{H}) = 1, A_r(\text{N}) = 14$
- 1.25 mol
 - 28 dm³**
 - 14 dm³
 - 0.56 dm³
56. Calculate the pH of a $1 \cdot 10^{-4}$ mol dm⁻³ HNO₃ solution:
- 4**
 - 10
 - 3
 - 10^{-4}
57. We have a solution of HNO₃, in which the molar concentration of the H₃O⁺ ion is equal to 0.01 mol dm⁻³. For this solution, it holds that:
- its pH is 2**
 - its pH is 1
 - the molar concentration of HNO₃ is equal to $1 \cdot 10^{-2}$ mol dm⁻³
 - the molar concentration of OH⁻ is equal to $1 \cdot 10^{-12}$ mol dm⁻³
58. Calculate the concentration of OH⁻ in a 1 mM aqueous solution of HCl.
- 10^{-11} mol dm⁻³**
 - 10^{-7} mol dm⁻³
 - 10^{-3} mol dm⁻³
 - 10^{-14} mol dm⁻³
59. The substance concentration of hydroxide ions in an aqueous solution is $1 \cdot 10^{-8}$ mol dm⁻³. Calculate the pH of this solution and decide whether the solution is acidic or alkaline:
- the solution is acidic; pH = 6.0**
 - the solution is basic; pH = 6.0
 - the solution is basic; pH = 8.0
 - the solution is acidic; pH = 8.0
60. What is the pH of the solution prepared by mixing 10 ml of a $0,1$ mol dm⁻³ NaOH solution with 90 ml of water?
- 2
 - 13
 - 12**
 - 11

61. Reactions of chlorine with CH_4 and with C_2H_4 are:

- a) additions
- b) eliminations
- c) a substitution and an addition**
- d) substitutions

62. Electrophilic reagent(s) is/are:

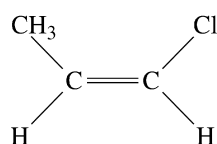
- a) H_3O^+**
- b) OH^-
- c) H_2O
- d) NO_2^+**

63. Vinyl alcohol and acetaldehyde are:

- a) enantiomers
- b) optical isomers
- c) tautomers**
- d) conformational isomers

64. The compound with this formula is called:

- a) 3-chloro-prop-2-ene
- b) *cis*-1-chloro-prop-1-ene**
- c) *trans*-1-chloro-prop-1-ene
- d) 1-methyl-3-chloro-eth-1-ene



65. The molecule which contains seven σ bonds is:

- a) acetic acid**
- b) acetone
- c) ethanol
- d) acetaldehyde

66. How many alkyls can be derived from butane?

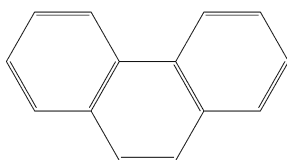
- a) four
- b) two**
- c) one
- d) three

67. *p*-xylene is:

- a) 1,2-dimethylbenzene
- b) 1,4-dimethylbenzene**
- c) methylbenzene
- d) 2-methyl-4-ethylbenzene

68. The compound with this formula is called:

- a) anthracene
- b) naphthalene
- c) biphenyl
- d) phenanthrene**



69. Carotenoids belong to

- a) heterocycles
- b) tetraterpenes**
- c) steroids
- d) alkaloids

70. Can an alcohol with three carbons in the molecule be a tertiary alcohol?

- a) yes, it depends on the number of -OH
- b) no, never**
- c) yes, if it is trivalent
- d) yes, it depends on the -OH position

71. The product of methanol oxidation can be:

- a) acetic acid
- b) methanal**
- c) ethanol
- d) acetaldehyde

72. Quinones can be formed by:

- a) oxidation of phenols with two -OH groups in the *ortho* position**
- b) oxidation of phenols with two -OH groups in the *para* position**
- c) oxidation of phenols with two -OH groups in the *meta* position
- d) oxidation of phenols with one -OH group

73. Compounds of phenols with sodium hydroxide can be classified as:

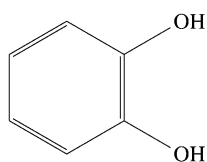
- a) esters
- b) salts**
- c) soaps
- d) ethers

74. Formaldehyde is formed by dehydrogenation of:

- a) formic acid
- b) methanol**
- c) ethane
- d) acetaldehyde

75. The compound with this formula is called:

- a) *o*-benzenediol
- b) benzene-1,2-diol
- c) pyrocatechol
- d) resorcinol



76. How many carbon atoms does a molecule of phenyl(methyl)ketone contain?

- a) seven
- b) five
- c) ten
- d) eight

77. Which of these molecules is/are ether(s)?

- a) $\text{HCO}-\text{CH}_3$
- b) $\text{CH}_3-\text{O}-\text{CH}_3$
- c) $\text{CH}_3-\text{CO}-\text{CH}_3$
- d) $\text{CH}_3-\text{CO}-\text{O}-\text{CH}_3$

78. Esterification is the reaction of:

- a) alcohols with inorganic acids
- b) alcohols with carboxylic acids
- c) alcohols with strong bases
- d) carboxylic acids with strong bases

79. Pyruvic acid is formed from lactic acid by:

- a) dehydration
- b) decarboxylation
- c) isomerization
- d) dehydrogenation

80. Urea is:

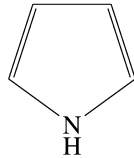
- a) purine derivative
- b) amino acid
- c) carbonic acid diamide
- d) acetic acid diamide

81. Which of the following belong(s) to oxygen-containing heterocyclic compounds?

- a) imidazole
- b) thiophene
- c) furan
- d) pyridine

82. The compound represented by this structural formula is called:

- a) pyrimidine
- b) pyrrole**
- c) purine
- d) pyridine



83. The building blocks of disaccharide lactose are:

- a) D-fructofuranose and D-glucopyranose
- b) 2-deoxy-D-ribose and D-glucopyranose
- c) D-glucopyranose and D-glucopyranose
- d) D-galactopyranose and D-glucopyranose**

84. Which of the following does not belong to polysaccharides?

- a) amylose
- b) maltose**
- c) cellulose
- d) insulin**

85. Oleic acid is:

- a) a saturated fatty acid
- b) a short-chain fatty acid
- c) an unsaturated fatty acid**
- d) an aromatic fatty acid

86. The basic type of bond between glycerol and a fatty acid residue in an acylglycerol (glyceride) is the:

- a) glycosidic bond
- b) hydrolytic bond
- c) ether bond
- d) ester bond**

87. Which of the following vitamins are classified as water soluble:

- a) retinol
- b) calciferols
- c) biotin**
- d) riboflavin**

88. The human body requires vitamin K:

- a) to keep blood clotting functional**
- b) to prevent night-blindness
- c) for correct bone development**
- d) as a protection against scurvy

89. Which of the following compounds have/has a steroid structure:
- a) **corticosteroids**
 - b) adrenaline
 - c) **cholesterol**
 - d) **testosterone**
90. The pancreas produces:
- a) **insulin**
 - b) **glucagon**
 - c) parathormone
 - d) adrenalin
91. The essential amino acids in the human body:
- a) are produced by keto acid oxidation
 - b) are produced by keto acid transamination
 - c) **are not produced, they are supplied in the diet**
 - d) are produced by keto acid dehydrogenation
92. Which of the following amino acids contain(s) sulphur in its molecule?
- a) tryptophan
 - b) alanine
 - c) serine
 - d) **cysteine**
93. Mark the correct sequence of atoms in the main chain of a protein molecule:
- a) **-N-C-C-N-C-C-N-C-**
 - b) -N-C-N-C-
 - c) -N-C-O-C-N-C-O-
 - d) -S-S-C-S-S-C-
94. Proteins:
- a) **may have a secondary structure in the form of β -folded sheet or α -helix**
 - b) **are composed of L-amino acids**
 - c) are composed of D-amino acids
 - d) are all well soluble in water
95. Collagen occurs mainly in:
- a) **skin and tendons**
 - b) blood and urine
 - c) natural silk
 - d) milk

96. **Coenzyme is:**

- a) a radical
- b) another name for substrate
- c) the enzyme's protein molecule itself
- d) a non-protein molecule necessary for the enzyme to function**

97. **During its β -oxidation, the fatty acid gets degraded stepwise to:**

- a) acetyl coenzyme A**
- b) pyruvic acid
- c) lactic acid
- d) acylglycerol

98. **In humans, the main end product of the metabolism (biodegradation) of protein nitrogen is:**

- a) ammonia
- b) purine bases
- c) uric acid
- d) urea**

99. **Which of the following belongs to the monosaccharide components of nucleic acids?**

- a) 2-deoxy-D-ribose**
- b) D-ribose**
- c) D-ribulose
- d) L-ribose

100. **Which purine bases are components of nucleic acids?**

- a) adenine**
- b) cytosine
- c) thymine
- d) guanine**