Medical and biological physics (sample questions with answers). Module 2

1. *Translation* is
A. a circular motion
B. a motion along a straight line
C. a motion along the sinusoid
D. the spinning of a rigid body around affixed axis
E. deformation of an object

2. Rotational motion (pure rotation) is
A. the spinning of a rigid body around affixed axis
B. a motion along a straight line
C. is the same thing as free undamped oscillations
D. is the same thing as forced oscillations
E. the autooscillations

3. Rotatory movement equation of a rigid body is α= 6+7t. Find the angular velocity ω
A. 6
B. 0
C. 13
D. 7
E.1

4. Rotatory movement equation of a rigid bodyis $\alpha = 6 + 10t + 3t^2$. Find the angular acceleration β.
A. 10
B. 6
C. 3
D. 16
E. 19

5. At an irregular rotational motion the instantaneous angular velocity $\boldsymbol{\omega}$ is determined by a formula
A. $\omega = \lim\limits_{\Delta t \to 0} \frac{\Delta t}{\Delta \alpha} = \frac{dt}{d\alpha}$
B. $\omega = \frac{\Delta \alpha}{\Delta t}$
C. $\omega = \lim\limits_{\Delta t \to 0} \frac{\Delta \alpha}{\Delta t} = \frac{d\alpha}{dt}$
D. $\omega = \frac{\Delta t}{\Delta \alpha}$
E. $\omega = \frac{d\alpha}{dt} \cdot r$
where Δα is an angular displacement; Δ*t* is time interval during which an angular displacement occurs; r is radius of the circle traveled by the point around the axis of rotation.

6. At an irregular rotational motion the instantaneous angular acceleration $\boldsymbol{\beta}$ is defined by formula
A. $\beta = \lim\limits_{\Delta t \to 0} \frac{\Delta t}{\Delta \omega} = \frac{dt}{dw}$
B. $\beta = \frac{\Delta \alpha}{\Delta \omega}$

C. $\beta = \lim_{\Delta t \to 0} \frac{\Delta\omega}{\Delta t} = \frac{d\omega}{dt}$

D. $\beta = \frac{\Delta t}{\Delta\omega}$

E. $\beta = \frac{d\omega}{dr} \cdot \alpha$

where $\Delta\alpha$ is angular displacement; Δt is time interval during which an angular displacement occurs; dr is change of position; $\Delta\omega$ is an in increment of angular velocity

7. The radial component of linear acceleration $\boldsymbol{a_r}$ in any the point can be calculated by the formula

A. $a_r = \frac{v}{r^2} = \omega r^2$

B. $a_r = \frac{v^2}{r} = \omega^2 r$

C. $a_r = \frac{\omega^2}{r} = v^2 r$

D. $a_r = \frac{\omega}{r^2} = v r^2$

E. $a_r = \frac{v^2}{r^2} = \omega^2 r^2$

where ω is an angular velocity; v is a linear velocity; r is a radius of the circle traveled by the point around the axis of rotation

8. The angular momentum $\vec{L}$ of a particle of mass m with linear momentum $\vec{P} = m\vec{v}$ with respect to the rotation axis is a vector quantity defined as

A. $\vec{L} = \frac{\vec{r}}{\vec{p}}$

B. $\vec{L} = \vec{r} \cdot (\vec{p})^2$

C. $\vec{L} = \vec{r} \cdot \vec{p}$

D. $\vec{L} = \frac{\vec{p}}{\vec{r}}$

E. $\vec{L} = (\vec{r})^2 \cdot \vec{p}$

where ω is an angular velocity; v is a linear velocity; $\vec{r}$ is a position vector of the particlewith the respect to axis of rotation.

9. Absolute value of angular momentum (L) can be calculated by formula

A. $L = I\omega^2$

B. $L = I^2\omega$

C. $L = I\omega$

D. $L = I/\omega$

E. $L = I^2/\omega$

where ω is an angular velocity; *I* is a moment of inertia.

10. Kinetic energy of rotating body ***K* = *4000 J***, rotation radius ***r* = *2* m**, angular velocity ***ω = 20 rad·s⁻¹***. Mass of rotating body is
A. 1 kg
B. 2 kg
C. 5 kg
D. 10 kg
E. 20 kg

11. Determine value of linear thermal expansion coefficient of a material, if at heating the rod by the length 0.5m, from the temperature t_1 = 20°C to t_2=100 °C its length changes from L_0=0.5m to L=0.504m
A. 10^{-6}
B. 10^{-5}
C. 10^{-4}
D. 10^{-3}
E. 10^{-2}

12. The ideal fluid is
A. incompressible and viscous liquid
B. compressible and viscous liquid
C. completely incompressible and non-viscous
D. water at temperature 100^0C
E. a blood

13. Rheology is the field of physics studying
A. electrical properties of bodies
B. magnetic properties of bodies
C. optical properties of bodies
D. deformation and fluidity of real media
E. quantum properties of various medium

14. In the Bernoulli equation $p + \rho gh + \frac{\rho \upsilon^2}{2} = const$ the value p is called
A. hydrostatic pressure
B. static pressure
C. dynamic pressure
D. height of the level of liquid
E. weight of liquid

15. The relative volume of erythrocytes in blood in percentage is called
A. Casson's factor
B. viscosity of blood
C. velocity of the shear
D. stress of the shear
E. haematocrite value

16. Diastolic arterial pressure is approximately equal to
A. 10 Pa

B. 11 kPa
C. 0.1 kPa
D. 1.1 kPa
E. 1 Pa

17. The Reynolds number (Re) can be calculated by the formula
A. $\mathrm{Re} = \rho v D \eta$
B. $\mathrm{Re} = \rho/\eta$
C. $\mathrm{Re} = \rho v D$
D. $\mathrm{Re} = \rho v D/\eta$
E. $\mathrm{Re} = vD/\eta$
where ρ is a density of the fluid; ν is a average velocity of the fluid in the pipe; D is a diameter of the pipe; η is a dynamic viscosity

18. In the Newton's formula for viscosity $\tau = \eta\dot{\gamma}$ the value τ is
A. volume flow rate of the fluid
B. viscosity of the fluid
C. velocity gradient absolute value
D. shear stress
E. average velocity of the fluid flow

19. Blood in terms of the rheology is
A. a pseudo-plastic liquid
B. a newtonian liquid
C. an ideal liquid
D. a viscous- plastic liquid
E. a homogeneous liquid

20. Systolic arterial pressure is approximately equal to
A. 16 kPa
B. 11 kPa
C. 1.6 kPa
D. 1Pa
E. 160 kPa

21. The Bernoulli equation $p + \rho gh + \frac{\rho \upsilon^2}{2} = const$ is valid only for
A. viscous fluid
B. compressed fluid
C. blood
D. ideal fluid
E. water at temperature 100^0C

22. The Newton's formula for the force of viscous friction in terms of rheology is

A. $\tau = \eta / \dot{\gamma}$
B. $\tau = \dot{\gamma}$
C. $\dot{\gamma} = dV/dz$
D. $\tau = \eta \cdot \dot{\gamma}$
E. $tg\gamma = \Delta x / \Delta z$

where τ is the shear stress , η is the dynamic viscosity, $\dot{\gamma}$ is the shear velocity, dv/dz is the module of the velocity gradient, γ is the shear velosity

23. Blood has non-Newtonian properties due to
A. presence of the form elements
B. temperature
C. solar radiation
D. electrical properties
E. the correct answer is not present

24. If the value of Reynolds' number is more than its critical value (Re_{cr}), the fluid flow is
A. laminar
B. dependent on liquid temperature
C. turbulent
D. dependent on pipe lenght
E. dependent on pressure in a liquid

25. The equation of continuous flow $Q = s\upsilon = const$ is a manifestation of the law of
A. Archimede
B. conservation of mass
C. universal gravitation
D. conservation of a pulse
E. conservation of energy

26. Blood pulse wave is
A. blood velosity
B. pulse rate
C. the wave of the increased blood pressure, which is distributed in aorta and arterias
D. systolic pressure
E. diastolic pressure

27. The phenomenon of viscosity is connected with
A. Forces of interior friction between liquid layers
B. Electrical forces between fluid (gas or liquid) layers
C.Temperature gradient in gas or liquid
D.Forces of magnetic interaction
E. Gravitational forces

28. In the Poiseuille formula ($Q = \frac{\pi R^4 \Delta P}{8\eta\ell}$) the quantity Q is

A. the volume of real fluid passing through the cylindrical pipe cross section per unit time

B. the pipe radius
C. hydraulic resistance
D. the pipe length
E. pressure difference between the pipe ends

29. In the Poiseuille formula ($Q = \frac{\pi R^4 \Delta P}{8\eta\ell}$) the quantity R is
A. the pipe length
B. the volume of fluid passing through pipe
C. the pipe radius
D. the volume of a fluid passing through a pipe per second
E. pressure difference between the pipe ends

30. For the calculation of dynamic viscosity by a Ostwald’s method they measure
A. volume of studied liquid passing through a pipe per second
B. fluid velocity in the capillaries
C. efflux time of equal volumes of two fluids through the same capillary
D. lengths passed by reference and studied liquids during the same time
E. pressure difference between the capillary ends

31. Working formula for calculation of liquid viscosity by Hess’ method is
A. $\eta_x = \eta_0 \frac{L_x}{L_0}$
B. $\eta_x = \eta_0 \frac{\rho_x \cdot t_x}{\rho_0 \cdot t_0}$
C. $\eta_x = \eta_0 \frac{L_0}{L_x}$
D. $\eta_x = \eta_0 \frac{\rho_0 \cdot t_0}{\rho_x \cdot t_x}$
E. $\eta_x = \eta_0 \frac{\rho_0 \cdot t_x}{\rho_x \cdot t_0}$
where η_0 is the viscosity of reference fluid, ρ_x is the density of studied fluid, ρ_0 is the density of reference fluid, t_x is the average efflux time of the studied liquid, t_0 is the average efflux time of the reference liquid, L_x and L_0 are lengths passed by studied and reference liquids during the same time

32. Working formula for calculation of liquid viscosity by Ostwald’s method is
A. $\eta_x = \eta_0 \frac{L_x}{L_0}$
B. $\eta_x = \eta_0 \frac{\rho_x \cdot t_x}{\rho_0 \cdot t_0}$
C. $\eta_x = \eta_0 \frac{L_0}{L_x}$
D. $\eta_x = \eta_0 \frac{\rho_0 \cdot t_0}{\rho_x \cdot t_x}$

E. $\eta_x = \eta_0 \frac{\rho_0 \cdot t_x}{\rho_x \cdot t_0}$

where η_0 is the viscosity of reference fluid, ρ_x is the density of researched fluid, ρ_0 is the density of reference fluid, t_x is the average efflux time of the studied liquid, t_0 is the average efflux time of the reference liquid, L_x and L_0 are the lengths passed by studied and reference liquids during the same time

33. Physical nature of sound is
A. the mechanical waves propagating in elastic environments
B. the temperature fluctuations of elastic environment
C. the low-frequency electromagnetic waves
D. the electromagnetic waves of VHF-range
E. the radiowaves

34. Physiological (subjective) characteristic of sound is
A. the sound pressure
B. the intensity of a sound
C. the length of a wave
D. the frequency
E. the pitch of sond

35. The physical characteristic of a sound is
A. the sound pressure
B. the timbre
C. loudness
D. the level of loudness
E. the pitch of sound

36. In the Weber-Fechner law $E = k\lg(I/I_0(\nu))$ the value I is
A. the threshold of feeling
B. the threshold of audibility
C. the intensity of a sound
D. the loudness level of sound
E. a sound, perceived by the human ear

37. Unit of measurement of sound pressure in SI is
A. pascal (Pa)
B. watt (W)
C. joule (J)
D. newton (N)
E. pascal·second (Pa·s)

38. Method of measurement of hearing acuity is called
A. auscultation
B. audiometry
C. percussion
D. phonocardiography
E. electrocardiography

39. Human hearing organs perceive mechanical waves within the range of frequencies
A. from 16 Hz to 20 kHz
B. lower than 16 Hz
C. more than 20 kHz.
D. from 10^6 to $2 \cdot 10^6$ Hz
E. from 10^7 to 10^9 Hz
40. The sound intensity (I) is can be calculated by the formula
A. $I = P_0 \cdot 2\rho V$
B. $I = \frac{P_0}{2\rho V}$
C. $I = \frac{P_0^{\ 2}}{2\rho V}$
D. $P_0 = 2I\rho V$
E. $I = P_0^{\ 2} 2\rho V$
where ρ is the medium density; V is the sound propagation velocity; P_0 is the sound pressure amplitude

41. According to the Weber-Fechner law if to increase an irritation in an equal number of times, the sensation of this irritation
A. is increases on the equal value
B. is decreases on the equal value
C. is remain constant
D. decreases in geometric progression
E. is absent

42. Percussion is
A. graphical registration of heart sounds and noises
B. hearing sounds yielded by internal organs
C. ultrasonorgrapic detection
E. hearing sounds yielded by different parts of the body when tapped to determine their position, form and dimensions.
D. measurement of hearing acuity at different frequencies

43. In human auditory apparatus the transformation of mechanical oscillation to electrical signals occurs in
A. auditory tube
B. external acoustic meatus
C. eardrum
D. cochlea
E. auditory ossicles

44. The sound intensity level is L=10 dB at frequency ν=500 Hz. Determine the level of sound loudness
A. 0 phons
B. 20 phons
C. 10 phons
D. 30 phons
E. 40 phons

45. The level of sound loudness is E=20 phons at frequency ν=200 Hz. Determine the level of sound intensity.
A. 30 dB
B. 10 dB
C. 20 dB
D. 40 dB
E. 40 phons

46. The block-spring system moves in simple harmonic motion. When the block is at $x(t) = +2.0$ cm from the origin it has a kinetic energy of **K** = 3J and the spring has an elastic potential energy of **U**=2J. What is the kinetic energy when the block is at **x** = 0?
A. 5
B. 2
C. 3
D. 1
E. zero

47. A particle is oscillating in a simple harmonic motion with angular frequency of **ω** = 200 $\frac{\text{rad}}{\text{s}}$. Calculate the period (**T**) of the motion.
A. 10,0 s
B. $6.28\cdot10^{-1}$ min
C. $3.14\cdot10^{-2}$ s
D. 200. min
E. 628.14 min

48. A wave traveling along a string is described by equation s(x,t) = 0,37·sin[2,72(t-$\frac{x}{3.7\cdot10^{-2}}$)], in which the numerical constants are in SI units. Determine cyclic frequency of a wave.
A. 2,72
B. 0.37
C. $3.7\cdot10^{-2}$
D. 10
E. 100

49. A wave has cyclic frequency **ω** = 110$\frac{\text{rad}}{\text{s}}$ and wavelength **λ** = 6.28 m. Calculate the wave velocity (m/s).
A. 628
B. 6.28
C. 110
D. 314
E. 3140

50. A sinusoidal wave of frequency **ν** = 500 Hz has a speed **υ** = 350 m/s. What is the wavelength **λ** (m) of this wave?
A. 5.0
B. 0.3
C. 3.5
D. 0.7
E. 8.5

51. Free undamped oscillations are described by following differential equation

A. $\frac{d^2x}{dt^2} + \omega_0^2 x = 0$

B. $x + \omega_0 x = 0$

C. $x = kx + 85$

D. $\frac{d^2x}{dt^2} + 2\beta\frac{dx}{dt} + \omega_0^2 x = 0$

E. $x(t) = x_m \cdot e^{-\beta t} \cdot \sin(\omega t + \varphi_0)$,

where **x** is the displacement; $\boldsymbol{\omega_0}$ is the natural cyclic frequency; $\mathbf{x_m}$ is the amplitude; $\boldsymbol{\varphi_0}$ is the initial phase; **β** is the damping factor; **ω** is the cyclic frequency.

52. Solution of differential equation of the free undamped oscillations is

A. $\ddot{x} + \omega_0^2 x = 0$

B. $x + \omega_0 x = 0$

C. $x = x_0 \cdot \sin(\omega_0 t + \varphi_0)$

D. $\frac{d^2x}{dt^2} + 2\beta\frac{dx}{dt} + \omega_0^2 x = 0$

E. $x(t) = x_m \cdot e^{-\beta t} \cdot \sin(\omega t + \varphi_0)$,

where **x** is the displacement; $\boldsymbol{\omega_0}$ is the natural cyclic frequency; $\mathbf{x_m}$ is the amplitude; $\boldsymbol{\varphi_0}$ is the initial phase; **β** is the damping factor; **ω** is the cyclic frequency

53. Damped simple harmonic motion is described by following differential equation

A. $\frac{d^2x}{dt^2} + 2\beta\frac{dx}{dt} + \omega_0^2 x = 0$

B. $x + \omega_0 x = 0$

C. $x = x_m \cdot \sin(\omega_0 t + \varphi_0)$

D. $\ddot{x} + \omega_0^2 x = 0$

E. $\omega_0 = 2\pi\nu$

where **x** is the displacement; $\boldsymbol{\omega_0}$ is the natural cyclic frequency; $\mathbf{x_m}$ is the amplitude; $\boldsymbol{\varphi_0}$ is the initial phase; **β** is the damping factor; **ω** is the cyclic frequency; **ν** is the frequency of oscillations

54. In case of small friction the solution of the differential equation of damped simple harmonic motion is

A. $\ddot{x} + \omega_0^2 x = 0$

B. $x + \omega_0 x = 0$

C. $x = x_m \cdot \sin(\omega_0 t + \varphi_0)$

D. $\frac{d^2x}{dt^2} + 2\beta\frac{dx}{dt} + \omega_0^2 x = 0$

E. $x(t) = x_m \cdot e^{-\beta t} \cdot \sin(\omega t + \varphi_0)$

where **x** is the displacement; $\boldsymbol{\omega_0}$ is the natural cyclic frequency; $\mathbf{x_m}$ is the amplitude; $\boldsymbol{\varphi_0}$ is the initial phase; **β** is the damping factor; **ω** is the cyclic frequency

55. Thermodynamics studies
A. Processes with constant temperature
B. Forces that influence on heated bodies
C. Mutual conversions of the different kinds of energy in macroscopic systems
D. Motions of heated bodies
E. Changes of colors at heating bodies

56. Open system is called one if there is:
A. Heat and matter may cross the boundary of system
B. No exchanges of energy and matter between it and surroundings
C. Only exchange by energy between it and surroundings
D. Only matter my cross the boundary of system
E. Only charge may cross the boundary of system

57. The First Law of thermodynamics may assume the following mathematical expression
A. $\Delta E_{int} = Q - W$
B. $Q = \Delta E_{int} - W$
C. $\Delta E_{int} = Q + W$
D. $Q = \Delta E_{int}/W$
E. $\Delta E_{int} = Q/W$,
where Q – is heat, which system obtains from surroundings; W – is work done by the system to overcome external forces; ΔE_{int} – is changing of the internal energy.

58. The Hess Law approves that the thermal effect of chemical process:
A. Is determined through only by final and initial conditions of chemical systems
B. Depends on a path of transformation of intermediate stages of the given process
C. Is determined by given temperature
D. Depends on pressure of surroundings
E. Is determined by kinds of interact substances

59. In a human organism the food energy is spent for the fulfillment of the following works:
A. Only a work of transition of a body to overcome mechanical forces
B. Only a work of synthesis of high-molecular compounds from the low-molecular compounds during biomechanical reactions
C. Only osmotic work
D. Only a work of ions transport in electrical field
E. Mechanical, chemical, osmotic, and electric works

60. Changing of entropy dS can determine by formula:
A. $dS = T/dQ$
B. $dS = dQ - T$
C. $dS = T - dQ$
D. $dS = dQ/T$
E. $dS = T \cdot dQ$,
Where dQ – is a heat, delivered to the system; T – is absolute temperature of the system.

61. The Second Law of Thermodynamics states that:
A. The heat cannot of itself pass from a colder to a hotter body
B. It is possible to transfer heat from a cold to a hot reservoir without at the same time converting a certain amount of work to heat
C. The heat transferred to the system is expended in changing its internal energy only
D. The heat transferred to the system is expended in the work only

E. The heat can of itself pass from a colder to a hotter body

62. For normally functioning organism there is the following condition in the form:
A. $\frac{dS_e}{dt} = 0$
B. $\frac{dS_i}{dt} = 0$
C. $\frac{dS_i}{dt} + \frac{dS_e}{dt} \approx 0$
D. T = 0
E. $S_i + S_e = 0$,
where $\frac{dS_i}{dt}$ - is entropy producing rate in organism; $\frac{dS_e}{dt}$ - is the rate of negentropy entrance in organism; T – is absolute temperature.

63. The heat transferred to the system is 2 kJ. The system doesn't do the useful work. What is the internal energy change?
A. 1 kJ
B. 2 kJ
C. 3 kJ
D. 4 kJ
E. 0 kJ

64. The Goldman-Hodgkin-Katz equation determines dependence between
A. membrane resting potential and active concentrations of K^+, Na^+, Cl^- ions, and membrane permeability coeffitients for K^+, Na^+, Cl^- ions
B. action potential and concentration of K^+ ions
C. action potential and membrane permeability coefficient for various ions
D. membrane capacitance and membrane permeability for K^+ ions
E. resting potential and Na^+ concentration gradient

65. Thickness of biological membranes is approximately
A. 7 - 10 nm
B. 100 nm
C. 1000 nm
D. 200 nm
E. 200-300 nm

66. The main components of biological membranes are
A. K^+, Na^+, Cl^- ions
B. Nucleic acids
C. Amino acids
D. Phospholipides and proteins
E. Oxygen

67. Passive transport of substance
A. occurs in a direction of the substance concentration decrease

B. occurs in a direction of the substance concentration increase
C. is not connected with direction of concentration gradient
D. occurs in a direction of the increase of temperature
E. occurs in a direction of the decrease of temperature

68. At 37°C temperature membrane phoshpolipides have properties of
A. solid
B. crystals only
C. liquids only
D. both of liquids and crystals
E. both liquids and gases

69. In cells of the various organisms resting potential can have values in the range of about
A**. -50 to -100 mV**
B. -100 to -500 mV
C. -50 to -100 V
D. -1 to -10 V
E. +1 to +10 V

70. Na^+ - K^+ pump in membranes provides
A. diffusion by Ussing
B. passive transport of substances
C. active transport of substances
D. diffusion of chlorine ions into the cell from the outside
E. facilitated diffusion

71. In the Fick's equation $\left(J = -D\frac{dc}{dx}\right)$ value D is
A. membrane permeability
B. dimensionless coefficient
C. coefficient of the thermal conductivity
D. diameter of the pore
E. diffusion coefficient