**1.** Threshold of pain is

2. Why normal blood is non-Newtonian fluid?

3. Phase difference between current and voltage in circuit with ohmic resistance is:
a) $\varphi = \pi$ b) $\varphi = \pi/2$ c) $\varphi = 0$ d) $\varphi = 2\pi$

4. What formula describes the relation between wave intensity I and wave velocity v?
a) $I = \rho\omega Av$ b) $I = \frac{1}{2}\rho\omega Av$ c) $I = \frac{1}{2}\rho\omega^2 Av^2$ d) $I = \frac{1}{2}\rho\omega^2 A^2 v$ e) $I = \frac{1}{2}\rho\omega^2 A^2 v^2$

5. A-mode of US imaging has this name because "A" stands of:
a) amplify   b) amplitude   c) addition   d)acceleration   e) access

6. Unit of volume flow rate is
a) [m/s]   b) [m³/s]   c) [W/m²]   d) [J/s]

7. The next properties differentiate facilitated diffusion (FD) from simple diffusion (SD):
a) FD depends on concentration difference   b) FD is saturable
c) FD rate is higher than SD out of saturation region   c   d) FD can be blocked

8. What is impedance plethysmography?

9. After investigations of cell membrane under electronic microscope the next model was proposed:
a) sandwich model   b) monolayer model   c) bilayer model   d) fluid mosaic model

10. Goldman-Hodgkin-Katz equation is

11. The total number of magnetic field lines penetrating some area is called
a) magnetic induction   b) magnetic flux
c) induced electromotive force   d) magnetic dipole moment

12. Equation $Q = \frac{\pi r^4}{8\eta l} \cdot (p_1 - p_2)$ describes
a) continuity equation   b) Bernoulli's equation
c) Poissel's equation   d) Moens – Korteweg equation

13. Designate pulse amplitude I_0, pulse duration t_p, interpulse interval t_0 and period T on the scheme below:
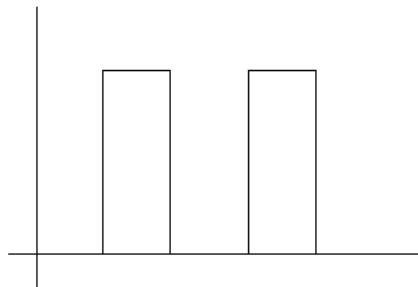
14. Viscosity in Ostwald's method of viscosity measurement is calculated by formula:
a) $\eta = \eta_0 \rho_0 t_0/(\rho t)$ b) $\eta = \eta_0 \rho t/(\rho_0 t_0)$ c) $\eta = \eta_0 \rho_0 t/(\rho t_0)$ d) $\eta = \eta_0\sqrt{\rho_0^2 t + \rho^2 t_0}$

15. Why real amplifier can distort signal?

16. In US imaging when target organ is deep in body we should ……. to reach it

a) increase frequency   b) decrease frequency
c) multiply frequency proportionally to depth   d) decrease frequency and decrease amplitude
17. How many times will have increased kinetic component of heart's works, if linear flow rate have increased by 50%? Why?
a) 0.5   b) 1.25   c) 2   d) 2.25   e) 2.5   f) 5   g) 1
18. Let the intercellular ion concentration is C_i; the extracellular ion concentration is C_e; R is the universal gas constant, T is the absolute temperature; F is the Faraday constant. With these denotations Nernst equation can be written as:

a) $\varphi_m = \dfrac{RT}{ZF}\ln\dfrac{C_i}{C_e}$ b) $\varphi_m = -\dfrac{RT}{ZF}\ln\dfrac{C_i}{C_e}$ c) $\varphi_m = \dfrac{RT}{ZF}\ln\dfrac{C_e}{C_i}$ d) $\varphi_m = -\dfrac{RT}{ZF}\ln\dfrac{C_e}{C_i}$

19. What is anisotropy of material?
20. Depicture amplitude characteristic of real amplifier:
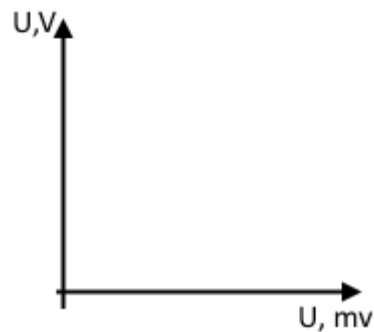
21. Which sorts of ions do form action potential of the cardiomyocyte?
a) Na^+ b) Mg^{2+} c) Ca^{2+} c) K^+ e) Li^+ d) H^+
22. Deformation is …

**23.** Is blood plasma a Newtonian fluid?
a) no   b) yes c) sometimes   d) never
24. Find the potential of electric dipole in point A, what is in the distance $r = 1$ m away from dipole, when dipole charge is $q = 0.5$ µC and dipole length is $l = 0.1$ µm. The angle between dipole moment and direction to the point A of is $\delta = 0°$.
a) $\phi = 9 \cdot 10^{-4}$ V   b) $\phi = 0$ V   c) $\phi = 9 \cdot 10^{-6}$ V   d) $\phi = \infty$ e) $\phi = 4.5 \cdot 10^{-4}$ V
25. What is amplifier?

26. Find approximately bandwidth of some amplifier using its frequency characteristic:
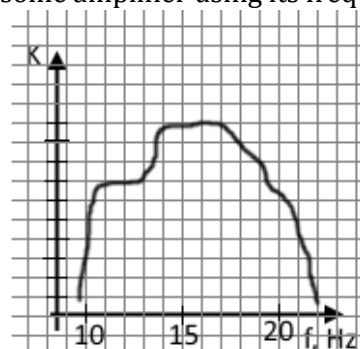
a) 9–22 Hz   b) 11–19 Hz   c) 14-17 Hz   d) 14-18 Hz
27. Impedance Z of circuit with capacity C, inductance L and ohmic resistance R connected in series can be found with next formula:

28. Quantity being denoting by ω_0 is called:
a) linear frequency   b) angular frequency c) acceleration   d) period   e) energy

2 from set B

29. Calculate amplification factor (gain), if some amplifier has increased voltage from 5 mV to 2.5 V.
a) 2   b) 20   c) 200   d) 2000   e) 5   f) 50   g) 500   h) 5000
30. What is electric dipole?

31. In galvanization procedure the maximum values of voltage U and amperage I are next:
a) $U = 30$ kV, $I = 0.15$ mA   b) $U = 3$ kV, $I = 1.5$ mA
c) $U = 80$ V, $I = 50$ mA   d) $U = 80$ kV, $I = 1.5$ A
32. What is the value of level L of intensity of sound wave in [dB] if the value I of it in [W/m²] is I=10⁻⁶?
a) 20 dB   b) 35 dB   c) 60 dB   d) 93 dB   e) 112 dB
33. When share rate is increasing blood viscosity is …
a) constant   b) increasing   c) decreasing   d) decreasing, but then increasing
34. During the rising phase of action potential attitude of the membrane permeability for K⁺, Na⁺ and Cl⁻ for giant axon of squid is:
a) 1:20:0.45   b)1:1:1   c)1:0.04:0.45   d) 1:0.08:0.55
35. Find conductivity of the electrolyte when ion's mobility (in $m^2/(s·V)$) are $\mu_+ = 4.5 \cdot 10^{-8}$, $\mu_- = 5.5 \cdot 10^{-8}$, carried charge is $q = 1.6 \cdot 10^{-19}$ C, dissociation coefficient $\alpha = 1$, volume ions concentration $n = 10^{22}$ $1/m^3$.
a) $1.6 \cdot 10^{-5}$ S/m   b) $1.6 \cdot 10^{-4}$ S/m   c) $1.6 \cdot 10^{5}$ S/m   d) $1.6 \cdot 10^{4}$ S/m
36. One knows that there are the next 5 phases in action potential: the refractory period (RePer), the peak phase (PePhase), the rising phase (RiPhase), the falling phase (FaPhase), the undershoot phase (UsPhase). Arrange them in the right order with respect to time.
a) RePer->PePhase->RiPhase->FaPhase->UsPhase
b) RiPhase->PePhase->FaPhase->UsPhase->RePer
c) UsPhase->FiPhase->PePhase->FaPhase->Reper
d) RePer->FaPhase->PePhase->RiPhase->UsPhase
37. Hematocrit is the relative …….. of erythrocytes (what word should be placed in gap?).
a) mass   b) hemoglobin concentration   c) volume   d) surface square
38. Equation $vS = const$, where v – linear flow rate, S – cross section square, describes
a) continuity equation   b) Bernoulli's equation
c) Poissel's equation   d) Moens – Korteweg equation
39. Which types of stress can be distinguished for muscles?
a) passive   b) viscoelastic   d) active   e) plastic
40. Cell membrane viscosity is near
a) 0.1 mPa·s   b) 1 mPa·s   c) 30-100 mPa·s
d) 0.1 Pa·s   e)1 Pa·s   d) 30-100 Pa·s
41. In a rest state attitude of the membrane permeability for K⁺, Na⁺ and Cl⁻ for giant axon of squid is:
a) 1:20:0.45   b)1:1:1   c)1:0.04:0.45   d) 1:0.08:0.55
42. When F is magnitude of force acting on conductor of length l with current I from uniform magnetic field with magnetic induction (magnetic flux density) B, α is the angle between induction and current direction, Ampere's law can be written next way:
a) $F = IlB \cos \alpha$ b) $F = IB \cos \alpha /l$ c) $F = IlB \sin \alpha$ d) $F = IB \sin \alpha /l$
43. In circuit with ohmic resistance R current amplitude I_{max} of AC with frequency f can be found through amplitude voltage U_{max} with next way:
a) $I_{max} = U_{max}/R$ b) $I_{max} = U_{max}/(2\pi f R)$ c) $I_{max} = 2\pi f U_{max} R$ d) $I_{max} = U_{max}$
44. What is the main advantage of differential amplifier?

45. There are two types of fluid flow:
a) laminar   b) half-laminar   c) turbulent   d) viscous
46. If threshold current is denoted with I_{thr} and pulse duration with t_p, a and b are constant, Weiss-Lapiqcue law can be written as:
a) $t_p = I_{thr}/a + b$ b) $a + b = I_{thr}/t_p$ c) $I_{thr} = a/t_p + b$ d) $I_{thr}/t_p = ab$

47. When maximum magnitude of force acting on conductor of length l with current I from uniform magnetic field is F_{max}, magnetic induction (magnetic flux density) B can be found next way:

a) $B = IF_{max}/(l)$ b) $B = F_{max}/(Il)$ c) $B = Il/(F_{max})$ d) $B = lF_{max}/(I)$

48. If membrane is transparent for one kind of ions (e.g. for K^+), and the concentrations of these ions are different on both sides of membrane, so membrane transport of these ions through membrane is occurred. This transport is characterized with equilibrium membrane potential φ_m, which is established when

a) concentrations of ions on both sides of membrane will be equal

b) electric charges on both sides of membrane will be equal

c) chemical potentials on both sides of membrane will be equal

d) electrochemical potentials on both sides of membrane will be equal

49. Why is body being heated when USW is traveling through it?

50. The relation between sound wave intensity I in [W/m²] and loudness E in [Phon] is given by this formula:

a) $E = k \lg(I/I_0)$ b) $E = -k \lg(I/I_0)$ c) $E = kI$ d) $E = kI/I_0$

1. Ultrasound has a frequency in range:
a) [0-20] Hz   b) [20-20,00] Hz   c) [20 kHz-10^{10}] Hz   d) [10^{10}-10^{14}] Hz

2. Frequency of self-excitation of pacemaker cells in atrioventricular (AV) node is
a) 60-100 /s   b) 40-55 /s   c) 30-40 /s   d) 15-25 /s

3. What is the value of work, having been spent on translocation of electric charge $q = 1$ μC from point $r_1 = 1$ m to point $r_2 = 2$ m? Source of the field is electric point charge equal $q_0 = 1$ mC.
a) A=4.5 J   b) A=6.75 J   c) A=13.5 J   d) A=0.25 J

4. Find the force acting between two point charges with values $q_1 = 1$ μC, $q_2 = 5$ μC, if the distance between them is $r = 0.1$ m.

5. What is the Lorentz force F acting on moving with velocity $v = 10^3$ m/s charge $q = 1.6 \cdot 10^{-19}\ C$ when the angle between magnetic field induction B and charge velocity $\alpha = 30°$?
a) $0.8 \cdot 10^{-19}$ N   b) $1.6 \cdot 10^{-19}$ N   c) $1.6 \cdot 10^{-16}$ N   d) $0.8 \cdot 10^{-16}$ N

6. Human body tissues are in generally...
a) diamagnetics   b) paramagnetics   c) ferromagnetics   d) superferromagnetics

7. Linear flow rate is found by formula:
a) $v = L/t$ b) $v = T/L$ c) $v = \sqrt{E/\rho}$ d) $v = \sqrt{Eh/\rho d}$

8. What is the creep of material?

9. RMS voltage U_{eff} is voltage of AC averaged per
a) period   b) 1 s   c) 2π s   d) phase

10. Choose ossicles in middle ear:
a) hammer   b) pinna   c) anvil   d) cochlea   e) round window

11. When maximum magnitude of force acting on conductor of length l with current I from uniform magnetic field is F_{max}, magnetic induction (magnetic flux density) B can be found next way:
a) $B = IF_{max}/(l)$ b) $B = F_{max}/(Il)$ c) $B = Il/(F_{max})$ d) $B = lF_{max}/(I)$

12. What is the value of level L of intensity of sound wave in [dB] if the value I of it in [W/m²] is I=10-6?
a) 20 dB   b) 35 dB   c) 60 dB   d) 93 dB   e) 112 dB

13. When period of pulse current is denoted with T, pulse duration with t_p, duty cycle Q can be found as:
a) $Q = T/t_p$ b) $Q = t_p/T$ c) $Q = 1 - t_p/T$ d) $Q = t_pT$

14. In AV node rate of action potential propagation drops from 1 m/s to 0.05 m/s to allow
a) ventricles to exite   b) atria to contract simultaneously
c) ventricles to repolarize   d) atria to contract in series

15. Equation $Q = \frac{\pi r^4}{8\eta l} \cdot (p_1 - p_2)$ describes
a) continuity equation   b) Bernoulli's equation
c) Poissel's equation   d) Moens – Korteweg equation

16. How to measure pulse using ECG?

17. Equation $vS = const$, where v – linear flow rate, S – cross section square, describes
a) continuity equation   b) Bernoulli's equation
c) Poissel's equation   d) Moens – Korteweg equation

18. What is the output voltage of the differential amplifier, if its gain is 10, and magnitude of the signal at the non-inverting input terminal is 8 mV, and magnitude of the signal at the inverting input terminal is -6 mV.
a) 14 mV   b) 140 mV   c) 2 mV   d) 20 mV   e) 48 mV   f) 480 mV

19. The lowest frequency in compound tone spectrum is called:
a) ground   b) entering   c) Fourier's frequency   d) fundamental

20. Let origin length of specimen is l_0, after deformation is l. Thus relative deformation (strain) ε of specimen can be calculated by this equation:
a) $\varepsilon = l_0 - l$ b) $\varepsilon = (l_0 - l)/l_0$ c) $\varepsilon = l_0/(l_0 - l)$ d) $\varepsilon = l$

21. What are the attributes of ideal fluid?
a) compressibility b) viscosity c) incompressibility   d) no viscosity e) turbulence

22. Phase difference between current and voltage in circuit with ohmic resistance is:
a) $\varphi = \pi$ b) $\varphi = \pi/2$ c) $\varphi = 0$ d) $\varphi = 2\pi$

23. Why real amplifier can distort signal?

24. Designate pulse amplitude I_0, pulse duration t_p, interpulse interval t_0 and period T on the scheme below:
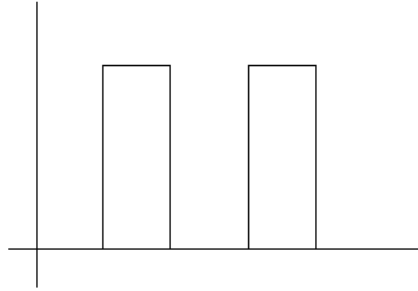
25. In alternating current (AC) applied to circuit voltage varies in time by next equation:
a) $U = U_0 e^{-kt}$ b) $U = U_0/t + b$ c) $U = U_0 \sin(\omega t + \varphi)$ d) $U = const$

26. For muscle stimulation pulse current frequency should be in range
a) 500-1000 Hz   b) 3-4 Hz   c) 100 kHz–1 MHz   d) 100-200 Hz

27. Why in Stoke's method of viscosity measurement density of fluid must be less than density of solid sphere?

28. Goldman-Hodgkin-Katz equation is

29. Have magnetic field lines starts and ends?
a) yes   b) no   c) sometimes   d) it depends on nature of magnetic fields

30. If membrane is transparent for one kind of ions (e.g. for K⁺), and the concentrations of these ions are different on both sides of membrane, so membrane transport of these ions through membrane is occurred. This transport is characterized with equilibrium membrane potential φ_m, which is established when
a) concentrations of ions on both sides of membrane will be equal
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a) $I_{max} = U_{max}/C$ b) $I_{max} = U_{max}/(2\pi f C)$ c) $I_{max} = 2\pi f U_{max}C$ d) $I_{max} = U_{max}$

33. Atria repolarization is masked in ECG with

a) T peak   b) QRS complex   c) P peak   d)ST segment

34. The next equation binds electric field intensity $\vec{E}$ and potential ϕ:

a) $\phi = div\,\vec{E}$ b) $\vec{E} = -\overrightarrow{grad\,\phi}$ c) $\phi = -div\,\vec{E}$ d) $\vec{E} = \overrightarrow{grad\,\phi}$ e)) $\vec{E} = -\phi\vec{n}$

35. In a rest state attitude of the membrane permeability for K$^+$, Na$^+$ and Cl$^-$ for giant axon of squid is:

a) 1:20:0.45   b)1:1:1   c)1:0.04:0.45   d) 1:0.08:0.55

36. What is value of polarization coefficient of tissue when at the frequency 10^3 Hz impedance was $2 \cdot 10^6$ Ohm, and at the frequency 10^6 Hz impedance was $2 \cdot 10^5$ Ohm?

37. The procedure of breaking of kidney stones or gallstones with USW is called:

a) phacoemulsification   b) phonophoresis   c) lithotripsy   e) US assisted liposuction

38. Forming of nerve signals of hearing sensation is going:

a) in vestibular canal   b) in tympanic canal   c) on basilar membrane   d) at helicotrema

39. In circuit with ohmic resistance R current amplitude I_{max} of AC with frequency f can be found through amplitude voltage U_{max} with next way:

a) $I_{max} = U_{max}/R$ b) $I_{max} = U_{max}/(2\pi f R)$ c) $I_{max} = 2\pi f U_{max}R$ d) $I_{max} = U_{max}$

40. Any complex type of deformation can be simplified to superposition of 2 next deformations:

a) shear   b) torsion   c) tension   d) bending   e) sliding

41. In iontophoresis positively charged drugs should be injected from ...

a) anode   b) catode   c) any electrode

42. Why is body being heated when USW is traveling through it?

43. Find conductivity of the electrolyte when ion's mobility (in m^2/(s·V)) are $\mu_+ = 4.5 \cdot 10^{-8}$, $\mu_- = 5.5 \cdot 10^{-8}$, carried charge is $q = 1.6 \cdot 10^{-19}$ C, dissociation coefficient $\alpha = 1$, volume ions concentration $n = 10^{22}$ 1/m^3.

a) $1.6 \cdot 10^{-5}$ S/m   b) $1.6 \cdot 10^{-4}$ S/m   c) $1.6 \cdot 10^{5}$ S/m   d) $1.6 \cdot 10^{4}$ S/m

44. When share rate is increasing blood viscosity is ...

a) constant   b) increasing   c) decreasing   d) decreasing, but then increasing

45. Which types of stress can be distinguished for muscles?

a) passive   b) viscoelastic   d) active   e) plastic

46. Ohm's law at point, linking current density j. electrical conductivity σ and electric field strength E is next:

a) $j = E/\sigma$ b) $j = \sigma/E$ c) $j = \sigma E$ d) $j = \sigma^2 E$ e) $j = E^2/\sigma$

47. SI unit of magnetic induction (magnetic flux density) is

a) T b) G c) $N \cdot m$ d) $A \cdot m^2$

48. Hematocrit is the relative …….. of erythrocytes (what word should be placed in gap?).

a) mass   b) hemoglobin concentration   c) volume   d) surface square

49. Cell membrane viscosity is near

a) 0.1 mPa·s   b) 1 mPa·s   c) 30-100 mPa·s

d) 0.1 Pa·s   e)1 Pa·s   d) 30-100 Pa·s

50. QRS complex at the ECG reflexes

a) ventricles excitation   b) atria excitation

b) ventricles relaxation   d) atria contraction