Фонд
оценочных средств

по дисциплине «Медицинская биофизика»

Уровень высшего образования

СПЕЦИАЛИТЕТ

Направление подготовки

560001 – КР лечебное дело (для иностранных студентов)

(код и наименование направления подготовки)

Квалификация

Врач-лечебник

2022

1. LIST OF COMPETENCIES INDICATING THE STAGES OF THEIR FORMATION DURING THE PROCESS OF MASTERING THE DISCIPLINE

Формируемые компетенции	Планируемые результаты обучения по дисциплине, характеризующие этапы формирования компетенций	Виды оценочных средств/ шифр раздела в данном документе
GSC-1: able and ready to analyze socially significant problems and processes, use the methods of natural sciences, mathematics and the humanities in various types of professional and social activities readiness to use basic physical, chemical, mathematical and other natural science concepts and methods in solving professional problems	**To know:** - Basic physical and chemical, mathematical and natural science concepts and laws; - Basic physical and chemical, mathematical and natural science methods; - General laws of natural science for solving professional problems	**Block A, D –** reproductive level tasks - test; - essay.
	To be able: - To use the basic laws of natural sciences; - To apply the methods of medical and biological and mathematical analysis with the use of experimental research; - To analyze the results of experimental studies	**Block B, D** – reconstructive level tasks - problem solving; - test.
	To master: - Methods of application of physical/chemical, mathematical and natural science laws; - Methods of solving professional problems using experimental studies; - Methods of analysis of the results of experimental studies	Block C, D – practice-oriented and/or research level assignments - prepared reports in a notebook based on the results of laboratory work, having the following structure: • Lab title. work; • Goal of the work; • Relevance; • Brief theoretical information; • Lab protocol table with research / measurements and numerical results of processing these measurements; • Conclusions.

2. TECHNOLOGICAL MAP OF THE DISCIPLINE

Technological map of the discipline "Medical biophysics"
Course 1, Semester 2, Number of credits - 2, Reporting - credit with assessment

Name of discipline modules according to the WP (according to the number of credits in the semester minus on CW (CP))	Control	Control form	Credit minimum	Credit maximum	Control schedule (week of the semester)
Module 1					
Section 1. Matemathics	**Current control**	**Activity, attendances;** **Independent work**	**4** **5**	**8** **9**	**7**
	Frontier control	**Control work №1 on Math**	**12**	**16**	
Module 2					
Section 2. Physics	**Current control**	**Activity, attendances;** **Independent work**	**4** **5**	**8** **9**	**18**
	Frontier control	**Lab reports, tests** **Essay**	**6** **4**	**10** **9**	
TOTAL in semester			**40**	**70**	**19**
Intermediate control (credit with assessment)			**20**	**30**	
Semester rating by discipline			**60**	**100**	

3. STANDARD CONTROL TASKS AND OTHER MATERIALS NECESSARY TO EVALUATE THE PLANNED LEARNING OUTCOMES IN THE DISCIPLINE / PRACTICE (ASSESSMENT TOOLS)

Block A

A. 1. **Questions to test the level of training "KNOW":**

- Fundamentals of differential and integral calculus
- Basic concepts of the theory of differential equations
- Basic concepts and theorems of probability theory
- Distribution laws and numerical characteristics of random variables
- Discrete and continuous distribution range. Polygon and histogram
- Point and interval estimations
- Correlation dependence. Correlation coefficient and its properties
- Error theory
- Undamped and damped free mechanical vibrations.
- Attenuation coefficient and logarithmic decrement, the relationship between them. Forced oscillations. Resonance.
- Self-oscillation.
- Doppler effect and its use for biomedical research.
- Characteristics of auditory sensation and their relationship to the physical characteristics of sound.
- Audiometry.
- Physical basis of sound research methods in the clinic.
- Ultrasound and infrasound
- Surface tension coefficient and methods of its determination.
- The phenomenon of wetting and non-wetting.

- Capillary events. Gas embolism.
- Viscous fluid flow. The basic law of viscous flow. Viscosity.
- Laminar flow and turbulent flow of liquids.
- The main indicators of hemodynamics.
- Pulse wave.
- Physical basis of blood pressure measurement.
- Mechanical properties of bone tissue.
- Mechanical properties of blood vessel tissue.
- Bio potentials. Resting potential. Action potential
- Biophysical principles of research of electric fields of tissues and organs
- Dipole equivalent electric generator of heart.
- Electrocardiography vector. Einthoven's Theory.
- Basic electrical properties of body tissues.
- Electrical conductivity of cells and tissues at direct and alternating current
- The effect on the human body of household electric current.
- Biophysics of ventricular fibrillation. Defibrillation.
- Application of electrical current and electromagnetic fields in medicine
- The mechanism of heating dielectrics and electrolytes in the electric UHF field.
- Thermocouple and its application to medicine.
- Sensors and their application in medicine
- Diffraction and interference of light.
- Diffraction grating.
- Refraction of light. Refractometer and work with it.
- The phenomenon of total internal reflection. Fiber optics and its use in medical devices.
- Methods for obtaining polarized light
- The passage of light through the polarizer – analyzer system. Malus law.
- Rotation of the plane of oscillations of polarized light. Optically active substances.
- Study of tissue structure in polarized light.
- X-ray radiation and its application in medicine.
- Ionizing radiation and their biological effect.
- Energy levels of biomolecules and electronic transitions in them.
- Luminescence of biological systems and its types.
- Light absorption
- Transmittance. Optical density of solutions.
- Photo biological processes and spectra of photo biological action.

A.2. Questions for midterm control

Module 1. MATHEMATICS

1) Fundamentals of differential and integral calculus
2) Basic concepts of the theory of differential equations
3) Basic concepts and theorems of probability theory
4) Distribution laws and numerical characteristics of random variables
5) Discrete and continuous distribution range. Polygon and histogram
6) Point and interval estimations
7) Correlation dependence. Correlation coefficient and its properties
8) Error theory

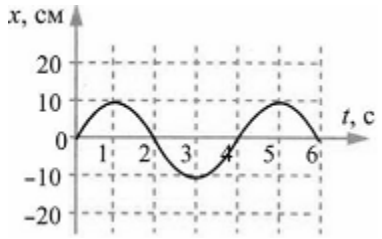
Module 2. MEDICAL BIOPHYSICS

LAB № 1. Study of oscillatory movements using a kymograph

1) Undamped and damped free mechanical vibrations.
2) Attenuation coefficient and logarithmic decrement, the relationship between them. Forced oscillations. Resonance.
3) Self-oscillation.
4) Doppler effect and its use for biomedical research.

TEST TASKS (EXAMPLES)

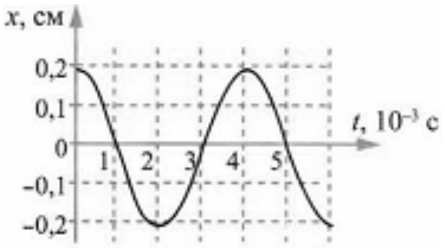
1. The figure shows the dependence of the coordinate of the center of a ball suspended on a spring on time. The oscillation amplitude is



a) 10 sm; c) 20 sm;

b) -10 sm; d) -20 sm.

2. The figure shows a graph of vibrations of one of the points of the string. According to the graph, the oscillation amplitude is equal to



a) $1 \cdot 10^{-3}$ m; c) $2 \cdot 10^{-3}$ m;

b) $3 \cdot 10^{-3}$ m; d) $4 \cdot 10^{-3}$ m.

11. Indicate the formula by which the amplitude of the damped oscillation is determined at any time ***t***:

a) $A_t = \pm A_0 e^{-\beta t}$;

b) $A_t = \pm A e^{-\beta t}$;

c) $A_t = A_0 e^{-\beta t}$;

d) $A_t = A_0 e^{-t}$.

12. The damping decrement is the ratio:

a) the first and third amplitudes;

b) two adjacent amplitudes separated by a period;

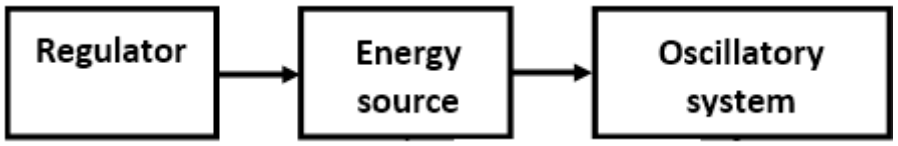
c) the first and last amplitudes;

d) two amplitudes separated by a half-cycle.

16. Indicate the block-scheme according to which self-oscillations are carried out:

a)

b)



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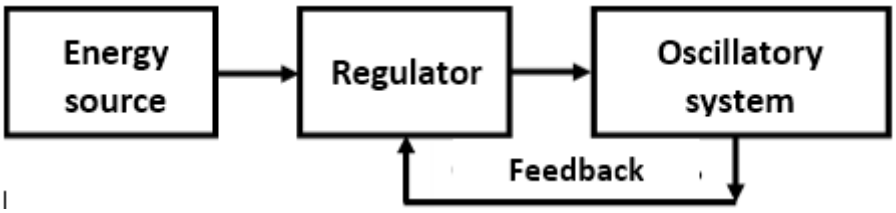

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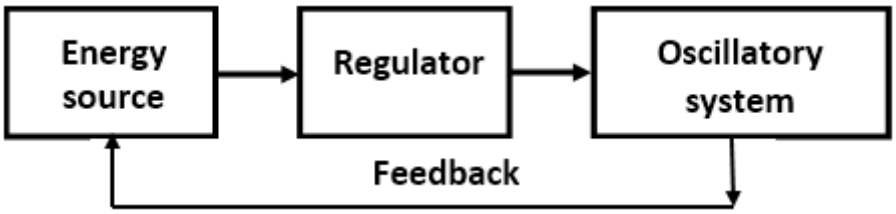


32. Resonance is called ....

a) the phenomenon of penetration of one substance into another;

b) the phenomenon of a sharp increase in the amplitude of forced oscillations when the frequency of the driving force coincides with the natural frequency of the oscillatory system;

c) the physical interaction of a liquid with the surface of a solid or other liquid;

d) the phenomenon is accompanied by intensity maxima and minima alternating in space.

33. The phenomenon of resonance can be observed in

a) any oscillatory system;

b) a system that performs free vibrations;

c) a self-oscillatory system;

d) a system performing forced oscillations.

LAB № 2. DETERMINATION OF THE COEFFICIENT OF THE SURFACE FLUID TENSIONS

1) Surface tension coefficient and methods of its determination.
2) The phenomenon of wetting and non-wetting.
3) Capillary events. Gas embolism.

TEST TASKS (EXAMPLES)

1. The height of liquid rise in the capillary is determined by the formula:

a) $h = \frac{2\sigma\cos\alpha}{R\rho g}$;

c) $h = \frac{R\rho g}{2\sigma\cos\alpha}$;

b) $h = \frac{2\sigma\cos\alpha}{\rho}$;

d) $h = \frac{R}{2\sigma\cos\alpha}$

2. Specify the formula for additional pressure (Laplace formula):

a) $\Delta P = \frac{\sigma}{2r}$;

b) $P = \sigma \cdot r$;

c) $P = 2\sigma \cdot r$;

d) $\Delta P = \frac{2\sigma}{r}$.

3. Specify in which case the liquid wets the capillary wall:

a) if the liquid surface is perpendicular to the capillary wall;

b) if the liquid surface has a convex meniscus;

c) if the contact angle $\alpha < 90^0$;

d) if the contact angle $\alpha > 90^0$.

15. Surface tension is called

a) the property of a liquid to increase its free surface;

b) the property of a liquid to occupy the volume of the vessel in which it is located;

c) the property of a liquid to rise through narrow tubes;

d) the property of a liquid to contract its free surface.

16. The mechanism of occurrence of the surface tension force is explained by the presence of:

a) forces of intermolecular repulsion;

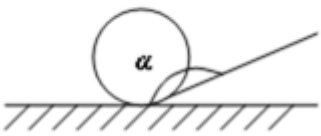
b) gravitational forces;

c) nuclear interaction forces;

d) forces of intermolecular attraction.

20. Indicate the figure for the wettability phenomenon, given through the contact angle:

a)



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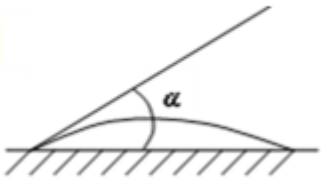

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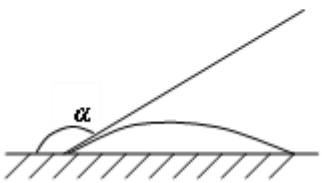

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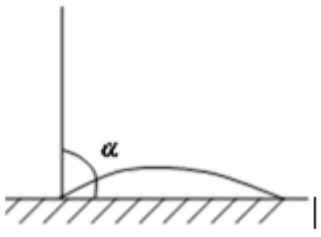


21. Capillarity is called:

a) the property of a liquid to reduce its free surface;

b) the property of a liquid to take the shape of the vessel in which it is located;

c) the property of a liquid during flow to break into separate layers;

d) the property of a liquid to rise and fall in thin tubes under the action of additional pressure.

30. With a decrease in the diameter of the capillary, the height of the rise of the liquid in the capillary

a) is increasing

b) decreases;

c) stays constant;

d) first decreases and then increases.

LAB № 3. DETERMINATION OF THE VISCOSITY COEFFICIENT OF A LIQUID

1) Viscous fluid flow. The basic law of viscous flow. Viscosity.
2) Laminar flow and turbulent flow of liquids.
3) The main indicators of hemodynamics.
4) Pulse wave.
5) Physical basis of blood pressure measurement.

TEST TASKS (EXAMPLES)

1. The Reynolds number can be calculated using the formula:

a) $Re = \frac{\rho_{ж}\vartheta}{\eta}$; c) $Re = \frac{2R\rho_{ж}\vartheta}{\eta}$;

b) $Re = \frac{2R}{\rho_{ж}\eta}$; d) $Re = \frac{R\rho_{ж}\vartheta^2}{\eta}$,

where R is the pipe radius;

$\rho_{ж}$ - liquid density;

ϑ is the average flow velocity over the pipe section;

η - coefficient of dynamic viscosity.

2. Newton's equation for the friction force between layers of a laminar flowing fluid can be written as:

a) $F = \frac{1}{\eta}\frac{\vartheta_2 - \vartheta_1}{z_2 - z_1} S$;

c) $F = \eta \frac{\Delta \vartheta}{\Delta z} S^2$;

b) $F = \eta \frac{\vartheta_2 - \vartheta_1}{z_2 - z_1} S$;

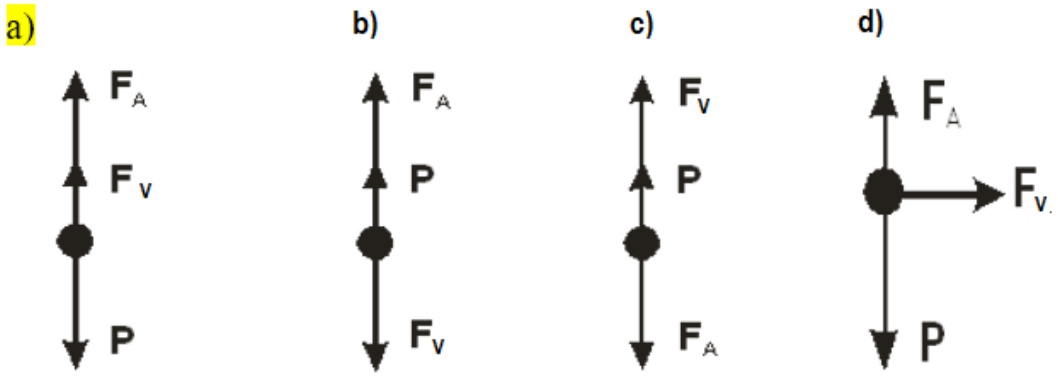
d) $F = \frac{\vartheta_2 - \vartheta_1}{z_2 - z_1} S$.

Here $\frac{\vartheta_2 - \vartheta_1}{z_2 - z_1} = grad\,\vartheta$ is flow velocity gradient,

$\boldsymbol{\eta}$ is the coefficient of dynamic viscosity,

$\boldsymbol{S}$ is the area of contact between the layers.

10. Indicate the vector diagram of the forces acting on the ball in the Stokes method for determining the viscosity coefficient:



21. With an increase in the area of contact of the liquid layers by a factor of 2, the force of internal friction

a) increases by 4 times;

b) decreases by 4 times.

c) decreases by 2 times;

d) increases by 2 times.

37. The flow rate of an ideal fluid flowing through a pipe of variable cross section at the point of narrowing of the pipe

a) will decrease

b) will not change;

c) first increases and then decreases;

d) will increase.

38. The property of a fluid to resist the movement of its layers relative to each other is called

a) fluidity;

b) turbulence;

c) viscosity;

d) wetting.

39. Relative blood viscosity is normal

a) 2 - 4; c) 4.2 - 6;

b) 20 - 23; d) 0.5 - 1.

40. Blood is classified as a non-Newtonian fluid because

a) it can flow laminar and turbulent;

b) its viscosity coefficient depends on the flow velocity;

c) it flows at different speeds in different parts of the vessels;

d) the friction force cannot be determined by Poiseuille's law.

41. Pulse Wave Velocity

a) many times greater than the speed of blood flow;

b) approximately equal to the linear velocity of blood flow;

c) a little more blood flow velocity;

d) is comparable to the speed of sound in a liquid.

LAB № 4. STUDYING THE ACTION OF ULTRA-HIGH-FREQUENCY (UHF) ELECTRIC FIELD ON SUBSTANCE

1) Application of electrical current and electromagnetic fields in medicine
2) The mechanism of heating dielectrics and electrolytes in the electric UHF field.
3) Basic electrical properties of body tissues.
4) Electrical conductivity of cells and tissues at direct and alternating current
5) The effect on the human body of household electric current.

TEST TASKS (EXAMPLES)

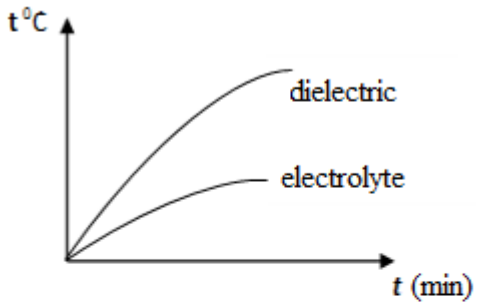
1. Specify the frequency of electric field exposure in the UHF-therapy method:

a) 27 - 300 MHz; d) 10 - 100 Hz;

b) 1 MHz; e) 300 MHz.

2. Indicate the graphs of the dependence of temperature on time for electrolytes and dielectrics under the action of a UHF electric field on them:

a)



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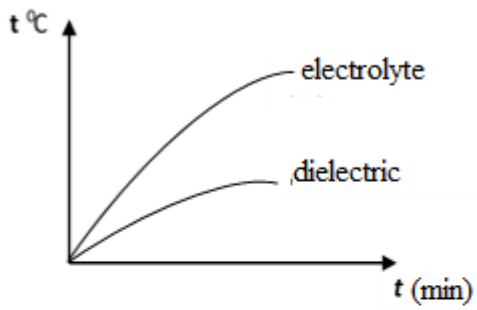

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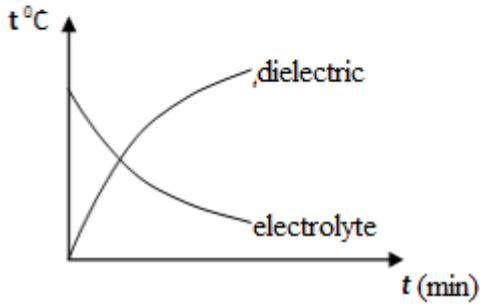

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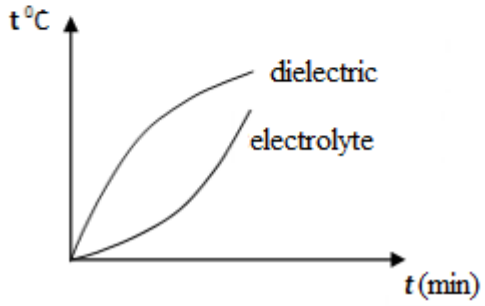
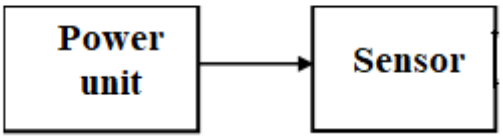


2. Indicate the block diagram of the UHF therapy device:

a)



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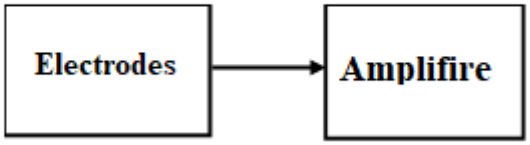

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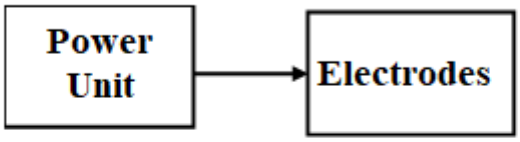

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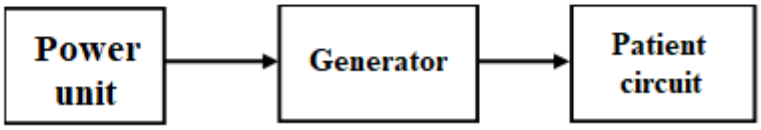


13. Heating of tissues during UHF therapy is due to

a) repolarization of cell membranes;

b) rotation and vibration of polar molecules;

c) depolarization of cell membranes;

d) irritation of nerve endings.

30. During inductothermy, the most active absorption of energy occurs:

a) in muscles and parenchymal organs;

b) in the bones;

c) in the skin;

d) in adipose tissue.

31. UHF therapy devices operate at a frequency:

a) 100 MHz;

b) 460 MHz;

c) 27.12 MHz and 40.68 MHz;

d) 110 MHz;

LAB № 5. PHYSICAL FOUNDATIONS OF ELECTROCARDIOGRAPHY

1) Biopotentials. Resting potential. Action potential
2) Biophysical principles of research of electric fields of tissues and organs
3) Dipole equivalent electric generator of heart.
4) Electrocardiography vector. Einthoven's Theory.
5) Basic electrical properties of body tissues.
6) Electrical conductivity of cells and tissues at direct and alternating current
7) The effect on the human body of household electric current.
8) Biophysics of ventricular fibrillation. Defibrillation.

TEST TASKS (EXAMPLES)

1. The current strength in the equivalent current electric generator of a cell located in a volumetric electrically conductive medium is determined by the formula:

a) $I = \frac{E}{R - R_0}$

c) $I \neq I_0;\ I = \frac{E}{R}$;

b) $I = \frac{R + R_0}{U}$;

d) $I = I_0 = \frac{E}{R + R_0}$

2. Complete the statement: "The current strength in the equivalent current electric generator of the cell and the total current in the external environment ....":

a) do not depend on the EMF of the generator;

b) do not depend on the internal resistance of the cell;

c) directly proportional to the internal resistance of the cell;

d) do not depend on the resistance of the external environment.

3. The main characteristic of the current dipole is the electric dipole moment, determined by the formula:

a) $\vec{Д} = \vec{I} \cdot S$;

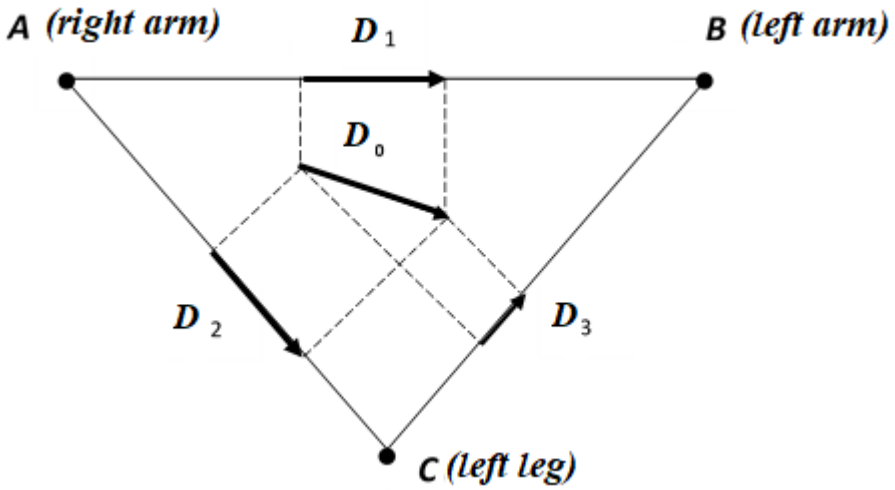
c) $\vec{I} = \vec{Д} \cdot l$

b) $\vec{Д} = \vec{I} \cdot l$;

d) $\vec{Д} = \frac{\vec{I}}{l}$

25. Specify Einthoven's triangle and its leads:

a)



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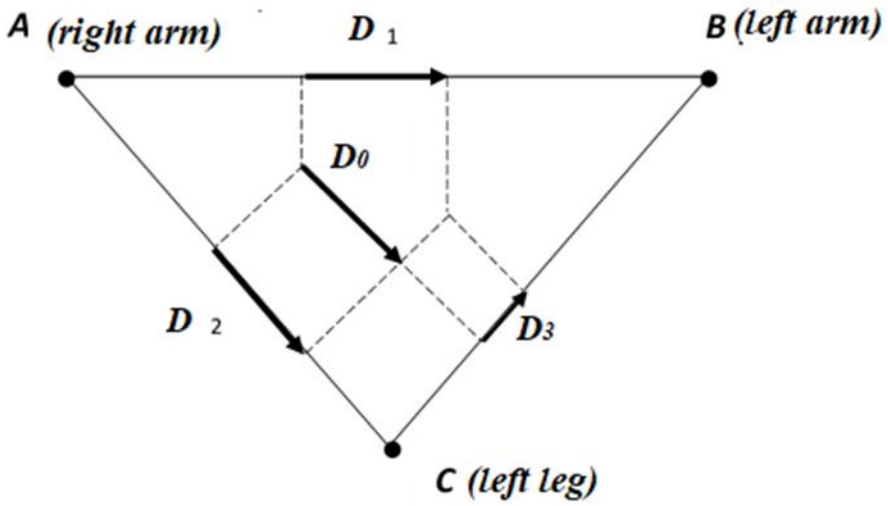
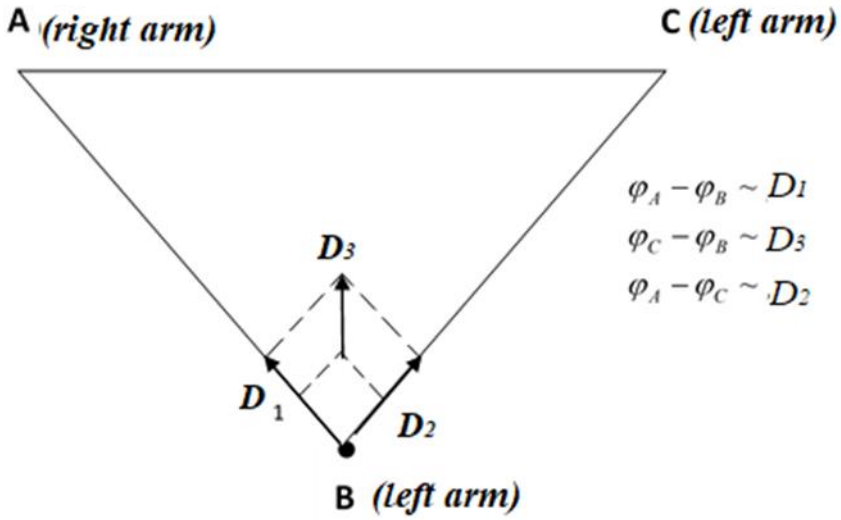
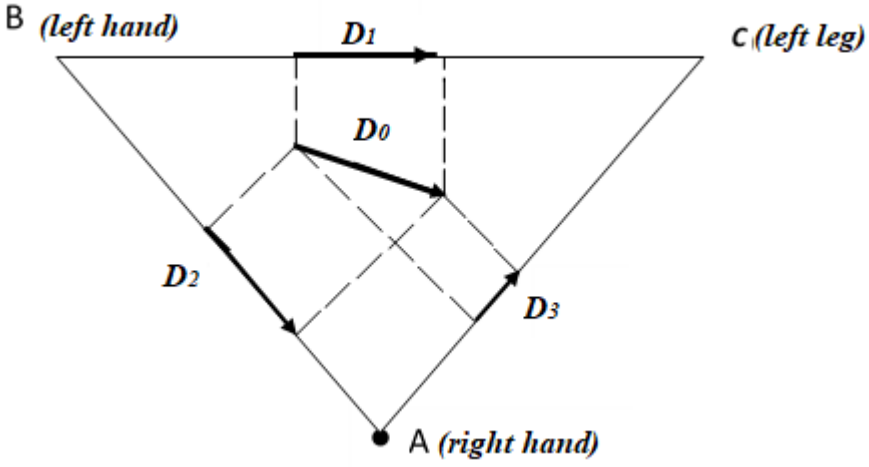

A (right arm)
D 1
B (left arm)
D0
D 2
D3
C (left leg)

c)


A (right arm)
C (left arm)
$\varphi_A - \varphi_B \sim D1$
$\varphi_C - \varphi_B \sim D3$
$\varphi_A - \varphi_C \sim D2$
D3
D 1
D2
B (left arm)

d)


B (left hand)
D1
C (left leg)
D0
D2
D3
A (right hand)

32. Indicate the model of the equivalent current electrical generator of a cell located in a volumetric electrically conductive medium: where

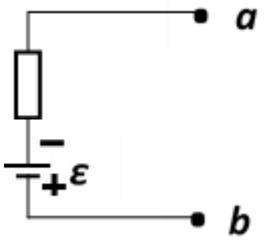
R is the intracellular current resistance;

R_0 is the resistance of the environment;

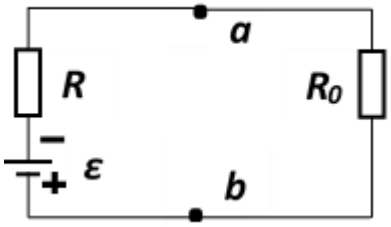
ε - EMF of the generator;

a, b – generator poles.

a)



b)



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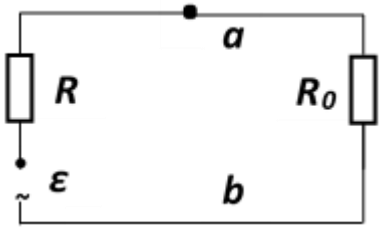
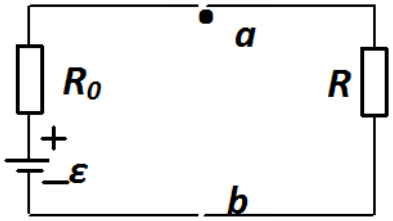


d)



LAB № 6. REFRACTO INDEX DETERMINATION OF LIQUIDS USING A REFRACTOMETER

1) Refraction of light. Refractometer and work with it.
2) The phenomenon of total internal reflection.
3) Fiber optics and its use in medical devices.

TEST TASKS (EXAMPLES)

3. When a light beam passes from a less optically dense medium to a more dense medium, the angle of incidence is:

a) more than the angle of refraction;

b) equal to the angle of refraction;

c) may be greater or may be less than the angle of refraction;

d) less than the angle of refraction.

4. The unit of measure for the relative refractive index is:

a) m; d) dimensionless quantity;

b) $\frac{м}{с}$; c) s^{-1}.

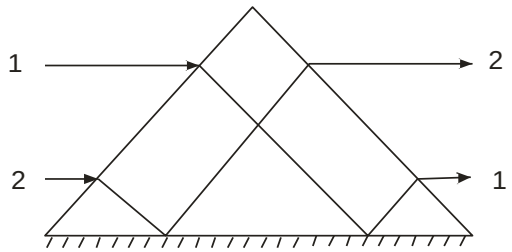
5. The formula for the absolute refractive index is:

a) $n_0 = \frac{\sin i}{\sin r}$; c) $n_0 = \frac{C}{\vartheta}$;

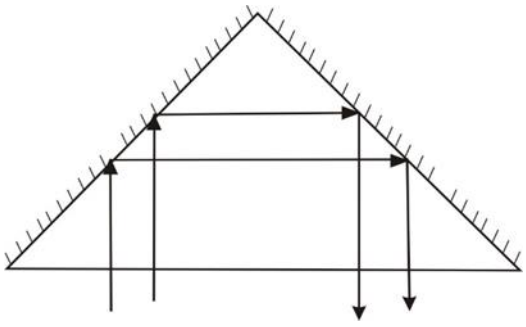
b) $n_0 = \frac{\vartheta_1}{\vartheta_2}$; d) $n_0 = \frac{\sin 90^\circ}{\sin \beta_{np}}$.

9. Indicate the path of the beam in the rotary prism:

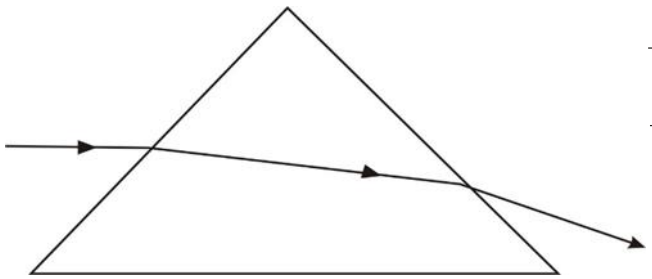
a)



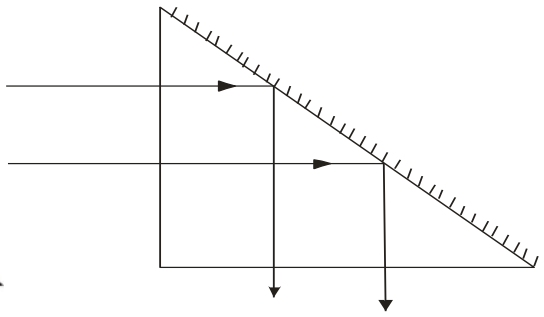
b)



c)



d)



28. Choose an expression to correctly complete the proposed phrase: "The refract metric method of analysis is based on ...":

a) the ability of substances to deflect the plane of polarization;

b) different speeds of light propagation in different media;

c) the ability of substances to dissipate light energy;

d) observation of the limiting boundaries of refraction or total internal reflection of a beam of light when passing from one medium to another;

29. Complete the phrase: "A refractometer is a device for measuring ..."

a) refractive index;

b) optical density;

c) angle of rotation;

d) molar absorption coefficient.

30. What parameters of a light wave change when it passes from one transparent medium to another?

a) wavelength;

b) frequency;

c) speed;

d) wavelength and frequency.

Block B

B.1. Standard problems

Topic 1. Differentiation and integration

Find derivatives for the following functions:

1. $y = 2ax^3$.
2. $y = 3\sqrt{x}$.
3. $y = 3e^{-x}$.
4. $y = x^3 + 2x^2 + 8$.
5. $y = 2\sqrt{x} - \sqrt[4]{x}$.
6. $y = x^4 - \ln x + 3^x$.

The concentration C of a certain substance decreases with the depth x of its penetration into the biological tissue according to the law

$$C(x) = C_0\left(1 - \frac{x^2}{k}\right),$$

where C_0 is a constant that determines the concentration on the surface of a biological tissue; k is a constant. Determine the concentration gradient.

Find full differentials for the following functions:

1. $u = ax^3 + \operatorname{tg} y$.
2. $u = e^{x/y}$.
3. $u = \sqrt{x^2 + y^2}$.
4. $u = 2x\sqrt{y}$.
5. $u = \sqrt{x} \cdot \sin^2 y$.
6. $u = a\cos(x^3 + 3y)$.
7. $W(x, v) = 0{,}5kx^2 + 0{,}5mv^2$.
8. $Q(x,y) = \dfrac{\pi x^4 P}{8ay}$.

Solve the problem:

The reaction of the body *R* to the introduction of a certain dose of a medicinal substance, depending on the time *t*, counted from the moment of administration, is described by the expression $R_1(t) = ate^{-t}$, where $a > 1$ is a constant coefficient. The reaction of the body to the introduction of another drug in the same dose is determined by the formula $R_2(t) = at^2 e^{-t}$. To what drug the response of a human organism is highest? Which drug acts more slowly?

Integration

Find indefinite integrals by direct integration (1–9) and by change of variable/substitution (10–18):

1. $\int 3x^3 dx$.
2. $\int \dfrac{dx}{2x^3}$.
3. $\int (4x^3 + 4x - 3)dx$.
4. $\int \dfrac{dx}{\sqrt{x}}$.
5. $\int (3x^2 + 2x - 1)dx$.
6. $\int \left(\dfrac{2}{x^2} - \dfrac{4}{\sqrt{x}} + 3\sqrt[3]{x^2} \right) dx$.
7. $\int x^2(1 - 2x)dx$.
8. $\int (\sqrt{x} + \sin x + e^x)dx$.
9. $\int \dfrac{\sin 2x}{\sin x} dx$.
10. $\int \cos 3x\, dx$.
11. $\int \sqrt{2x - 3}\, dx$.
12. $\int \sin^2 x \cos x dx$.
13. $\int e^{2x+1} dx$.
14. $\int e^{\cos x} \sin x dx$.
15. $\int \sin x \cos^5 x\, dx$.
16. $\int \dfrac{2x}{x^2 + 1} dx$.
17. $\int \dfrac{2dx}{3 - 4x}$.
18. $\int \dfrac{x^6 dx}{(x^7 - 2)^3}$.

Topic 2. Differential Equations

1. Check whether the given functions are solutions of the given differential equations:

1. $y' = 3x^2 + 2;\ y = x^3 + 2x.$
2. $yy' = x^2 + x;\ y = x + 1.$
3. $y' - 10\cos 5x = 0;\ y = 2\sin 5x + 8.$
4. $y'' = x^2;\ y = x^4/12.$
5. $y'' = + 4y = 0;\ y = A\sin 2t.$
6. $y'' = 6x;\ y = x^3 + 8x - 12.$
7. $y'' = x + y';\ y = \frac{1}{x}.$

2. Find general solutions of differential equations:

1. $y' = 2x^3 + 2.$
2. $y'e^x = 1.$
3. $yy' = x.$
4. $y' = 1/x + e^x.$
5. $(x + 7)dy = ydx.$
6. $y' = 12\sin 4x.$
7. $y' = y\cos x.$
8. $2xyy' = y^2 + 4.$

3. Find particular solutions of differential equations:

1. $2xy' = y$, если $x = 9,\ y = 6.$
2. $(x + 1)dy = ydx$, если $x = 1,\ y = 8.$
3. $3y^2y' = y^3 + 1$, если $x = 0,\ y = 2.$
4. $y' - 4\cos 2x = 0$, если $x = \pi,\ y = 5.$
5. $yy' = 2x^3$, если $x = 1,\ y = 3.$
6. $y' = 2 + \sin x$, если $x = 0,\ y = 4.$

Topic 3. Elements of the Probability Theory

1. Of the 11 people injured during the accident, 3 received fractures. The ambulance took away 2 victims. Find the probability that the victims without fractures will get into one car.

2. Fifteen people were taken to the hospital, six of them had a fever. They were placed in wards for 4 people. Find the probability that all patients with fever are in the same room.

3. During the accident, 25 people were injured, and 6 of them received fractures. Ambulance took away 2 victims. Find the probability that one car will get: a) two victims without fractures, b) two victims with fractures, c) one with a fracture, the other without a fracture.

4. During the icy conditions, 23 victims were taken to the hospital with fractures, five of them had a fever. In the wards of the victims were distributed by 3 people. What is the probability that everyone with a normal temperature will get into one room?

5. During the epidemic, 40% of the city's population were sick, and out of every 80, 10 required emergency ambulance. Find the probability that an ambulance will be needed by any randomly taken resident of the city.

6. The student came to the exam knowing the answers to 62 out of 90 exam questions. There are 5 questions on the ticket. Find the probability that the student answers all the questions on the ticket.

7. In a batch of 20 devices, 4 turned out to be faulty. What is the probability that out of 3 devices chosen at random, at least one will be faulty?

Topic 4. Fundamentals of mathematical statistic

1. The volume of circulating blood (l) xi - with the frequency of occurrence, mi – accepted the following values:

x_i	4,83	5,08	3,81	5,34	4,06	5,37	4,32
m_i	20	10	4	3	3	5	5

-Find the probability that the volume of circulating blood is V≤5.00 (L)
-Construct a polygon of frequencies.

2. Calculate the coefficient of a paired linear correlation dependence, draw a conclusion about the sign of the correlation and the degree of connection of the following quantities:

Thyroid weight (g)	12	59	62	95	102	23	203	270
Image area (cm^2)	11	32	33	44	46	17	73	89

3. Women's height measurements are represented by a statistical interval distribution series:

x_i (*см*)	148-152	152-156	156-160	160-164	164-168	168-172	172-176
m_i	2	11	15	25	13	3	1

-Find the probability that women's height is x<162 cm.
-Construct a histogram.

4. Calculate the coefficient of a paired linear correlation dependence; draw a conclusion about the sign of the correlation and the degree of connection of the following quantities:

The volume of circulating blood (l) *xi*	4,83	5,08	3,81	5,34	4,06	5,34	4,32	5,59
Height (cm)	170	175	150	175	155	180	160	185

5. Values of upper arterial pressure *xi* with the frequency of occurrence mi take the following values:

x_i (*мм.рт.ст*)	87	120	135	90	110	115	160
m_i	4	48	2	3	25	15	3

-Find the probability that the upper arterial pressure is less than or equal to 120 mm Hg
-Construct a polygon of frequencies.

6. Calculate the coefficient of a paired linear correlation dependence, draw a conclusion about the sign of the correlation and the degree of connection of the following quantities:

The amplitude of the evoked potentials of the brain (μV)	2.3	4.0	7.4	4.5	6.7	10.0	9.2	10.8
Latent period (ms)	15.7	20.6	25.6	34.6	48.5	66.6	96.1	127.2

Block C

C.2 Individual creative tasks

4. Physical basis of biomechanics.
5. Peculiarities of hemodynamics of the newborn.
6. Passive and active transport of substances through the membrane.
7. Biopotentials and their classification.
8. Physical basis of sound research methods in the clinic.
9. Ultrasound is its application in medicine.
10. Physical basis of hemodynamics.
11. Mechanical and electrical methods of blood circulation.
12. Low-frequency and high-frequency currents, their use in medicine.
13. Impulse currents and their use in medicine.
14. Physical bases of high-frequency methods of videolecture.
15. Polarization of biological tissues.
16. Impedance of biological tissues.
17. Physical basis of electrocardiography.
18. Saccharimetry and its application in medicine.
19. Optical quantum generators and their application in medicine.
20. Physical basis of holography and its application in medicine.
21. Ultra-weak glow and their use in medicine.
22. Radioactivity. The effect of radiation on humans
23. Physical basis of dosimetry.
24. Physical basis of magnetic therapy.
25. Sensors and their application in medicine.
26. Optical vision defects and ways to eliminate them.
27. Biophysics of color perception.
28. Biophysics of hearing.
29. Chemiluminescence of biological systems.
30. Spectrophotometry of biological fluids.
31. Nuclear magnetic resonance and its application in medicine.
32. Medical electronic systems.
33. Modern methods of osteosynthesis
34. Features of blood circulation of the fetus and newborn baby.
35. Thermography
36. Biologically active points.
37. Radiological methods of diagnosis of maxillofacial area
38. Physical and mechanical properties of composite materials.
39. Pathogenic effect of radioactive radiation on humans.

40. Age features of the structure of the eye and its appendages.
41. The equivalent electrical circuit of the tissues of the organisms.
42. Tensometry and determination of Poisson's ratio of dental materials.
43. The kinetics of the curing process of the sealing compositions by an ultrasonic method.
44. Application of ultrasound in dentistry.
45. Coefficient of linear and volumetric expansion.
46. Chemiluminometric and their importance in medicine.
47. Biomechatronics is an artificial hand.
48. Nanotechnology in medicine
49. Nanotechnology in Oncology
50. Nanotechnology in dentistry
51. Radiation situation in Kyrgyzstan.
52. Shape memory effect.
53. Physiotherapy in Pediatrics

Блок D

List of questions and tasks for intermediate certification (zachet with assessment):

Questions to check the level of training KNOW:

1. Undamped free mechanical vibrations.
2. Damped free mechanical vibrations.
3. Attenuation coefficient and logarithmic decrement, the relationship between them. Forced oscillations. Resonance.
4. Self-oscillation
5. Nature of sound. Physical characteristics of sound.
6. Characteristics of auditory sensation and their relationship to the physical characteristics of sound.
7. Weber – Fechner Law.
8. Audiometry. Hearing threshold and pain threshold.
9. Physical basis of sound research methods in the clinic.
10. Ultrasound. The effect of ultrasound on bio tissue, the phenomenon of cavitation.
11. Application of ultrasound in medicine.
12. Infrasound and its effect on the human body.
13. Mechanism of surface tension forces of liquids.
14. Surface tension coefficient and methods of its determination.
15. Derivation of the formula for determining the surface tension coefficient by the method of detachment of the ring.
16. The phenomenon of wetting and non-wetting.
17. Capillary events. Gas embolism.
18. Viscous fluid flow. The basic law of viscous flow.
19. Coefficient of viscosity and methods of its determination. Derivation of the Stokes formula.
20. Laminar flow of liquids. Pause Formula.
21. Turbulent fluid flow. Reynolds number.

22. The main indicators of hemodynamics: a) linear and volumetric blood flow rate; b) blood pressure.
23. Hemodynamic resistance (TPVR).
24. Pulse wave. The equation of the pulse wave. Moens Formula.
25. Physical basis of blood pressure measurement.
26. Deformation and its types.
27. The main characteristics of deformation. Hooke's law for elastic deformation.
28. Mechanical properties of bone tissue.
29. The average curve of deformation of compact bone.
30. Mechanical properties of blood vessel tissue.
31. Derivation of the Lame equation.
32. Biopotentials. Types of biopotentials (diffuse, membrane and phase).
33. - Resting potential. The Goldman Equation.
34. - Action potential. Hodgkin-Huxley Equation.
35. - Graph of the action potential of the nerve cell axon.
36. - Scheme of nerve impulse propagation (depolarization and repolarization). The velocity of the nerve impulse.
37. - Biophysical principles of research of electric fields of tissues and organs.
38. - The equivalent electrical generator cells.
39. - The potential of the electric field generated by the dipole and the dipole.
40. - The concept of multipole.
41. - Dipole equivalent electric generator of heart.
42. - Vector electrocardiography. Einthoven's Theory.
43. - Electrical conductivity of cells and tissues at constant current.
44. - Ohm's law for living tissue.
45. - The electrical conductivity of cells and tissue by the alternating current.
46. - Impedance. The equivalent electrical circuit of the tissues of the body.
47. - The effect on the human body of household electric current.
48. - Biophysics of ventricular fibrillation. Defibrillation.
49. - Application of direct current in medicine (galvanization and electrophoresis).
50. - The use of AC in medicine (diametre, darsonvalization, surgical diathermy, Deuteronomy).
51. - The mechanism of heating dielectrics and electrolytes in the electric UHF field.
52. - Medical applications of high frequency currents and electromagnetic fields (darsonvalization, surgical diametre, inductometer, UHF – therapy, microwave therapy).
53. - Contact potential difference.
54. - The mechanism of thermo-EMF. The formula of thermo-EMF.
55. - Thermocouple and its application to medicine.
56. - The calibration of thermocouples and the calibration graph. Determination of body temperature using a thermocouple.
57. - Sensors and their classification on the principle of action.
58. - Parametric sensors and the principle of their operation.
59. - Generator sensors and the principle of their operation.
60. - Diffraction and interference of light.

61. - Diffraction grating. The derivation of the diffraction grating.
62. - Laws of reflection and refraction of light.
63. - Absolute and relative refractive indices.
64. - Refraction of light. Refractometer and its purpose.
65. - The phenomenon of total internal reflection.
66. - Fiber optics and its use in medical devices.
67. - Natural and polarized light.
68. - Polarization of light at reflection and refraction at the boundary of two dielectrics. Brewster's Law.
69. - Polarization of light at double refraction.
70. - Nicola prism, the course of the rays in Nicola prism.
71. - The passage of light through the polarizer – analyzer system. Malus law.
72. - Rotation of the plane of oscillations of polarized light. Optically active substances.
73. - Optical scheme of the saccharimeter.
74. - Study of tissue structure in polarized light.
75. - The phenomenon of photoelectric effect. Laws of photoelectric effect.
76. - The device and the principle of operation of the vacuum and selenium solar cells.
77. - Nature and basic properties of x-rays.
78. - The device and the principle of operation of the x-ray tube.
79. - Brake x-rays and its spectrum.
80. - Characteristic x-ray radiation and its spectrum.
81. - Interaction of x-ray radiation with matter (coherent scattering).
82. - Interaction of x-ray radiation with the substance (photoelectric effect).
83. - Interaction of x-ray radiation with the substance (incoherent scattering or Compton effect).
84. - Application of x-rays in medicine.
85. - The basic law of radioactive decay.
86. - The half-life of radioactive nuclei. Activity.
87. - Penetrating and ionizing ability of radioactive radiation.
88. - Dosimetry of ionizing radiation (amount of radiation, radiation dose, dose rate, exposure dose).
89. - Biological dose of ionizing radiation. Protection against ionizing radiation.
90. - Biological effect of radioactive radiation on the human body.
91. - Energy levels of biomolecules.
92. - Electronic transitions in biological molecules (explain the scheme).
93. - Luminescence of biological systems and its types.
94. - The absorption of light by biosystems. Booger's law (derivation).
95. - The law of Lambert-Bouguer-Ber (derivation).
96. - Transmittance. Optical density of solutions.
97. - Photobiological processes and spectra of photobiological action.
98. - Evaluation of measurement errors of physical quantities.

Questions to check the level of training TO BE ABLE TO DO:

1. Find the variance of a random variable Z = 4X + 3 if the variance of the random variable X is known to be D(X) = 3.

2. 1) Measuring girls' weight xi of the age of 10 years old gave the following results:

X_i (kg)	19	20	21	22	23	24	25	26	27	28	29	30
f_i	2	1	6	8	21	20	18	12	3	4	2	3

Find the mean, the mode, the median, the range, the standard deviation, the variance.

3. The values of blood viscosity have the following values in the sample:

Blood viscosity X_i, Pa.c.10^{-3}	4,2	3,8	5,0	5,3	6,1	4,0	4,5	5,2	5,8	3,5	3,7
Number of patients m_i	18	12	21	9	2	28	31	8	7	4	10

Find the mean, the mode, the median, the range, the standard deviation, the variance.

4. The content of free heparin in blood X_i have the following values with the frequency of occurrence of m_i:

X_i, mg, %	5,7	5,9	6,3	5,6	4,1	4,0	4,5	5,0	5,1	6,7	4,9
m_i	5	11	2	7	4	15	13	23	9	1	8

5. Find the mean, the mode, the median, the range, the standard deviation, the variance.

Questions to check the level of training TO MASTER:

1. With a confidence probability of 0.95, calculate the confidence interval for the values of systolic blood pressure obtained during the dayю
2. Formulate a conclusion.

№ п/п	P_i *(mmHg)*	$\Delta P_i = \lvert \overline{P} - P_i \rvert$	ΔP_i^2	**σ, m**	$t_{0,95;n-1}$	**E%**	The confidence interval Δt
1	125						
2	132						
3	130						
4	126						
5	120						
	$\overline{P}$ =	$\Delta\overline{P}$ =	D =				

Conclusion:

1. With a confidence probability of 0.95, calculate the confidence interval, if the volume of circulating blood took the following values
2. Formulate a conclusion.

№ п/п	V_i ($м^3$)	$\Delta V_i = \lvert\overline{V} - V_i\rvert$	ΔV_i^2	σ, m	$t_{0,95;n-1}$	E%	The confidence interval Δt
1	4,1						
2	4,2						
3	5,0						
4	4,4						
5	4,7						
	$\overline{V}$ =	$\Delta\overline{V}$ =	D =				

Conclusion:

1. With a confidence probability of 0.95, calculate the confidence interval, if the dynamic viscosity of blood took the following values:
2. Formulate a conclusion.

№ п/п	η_i (10^{-3} мПа·с)	$\Delta\eta_i = \lvert\overline{\eta} - \eta_i\rvert$	$\Delta\eta_i^2$	σ, m	$t_{0,95;n-1}$	E%	The confidence interval Δt
1	3,7						
2	4,8						
3	4,0						
4	4,2						
5	4,4						
	$\overline{\eta}$ =	$\Delta\overline{\eta}$ =	D =				

Conclusion:

1. With a confidence probability of 0.95, calculate the confidence interval, if the pulse wave speed takes the following values
2. Formulate a conclusion.

№ п/п	ϑ_i $\left(\frac{м}{с}\right)$	$\Delta\vartheta_i = \lvert\overline{\vartheta} - \vartheta_i\rvert$	$\Delta\vartheta_i^2$	σ, m	$t_{0,95;n-1}$	E%	The confidence interval Δt
1	8,0						
2	7,7						

3	7,2						
4	7,4						
5	8,1						
	$\overline{\vartheta}=$	$\Delta\overline{\vartheta}=$	$D=$				

Conclusion:

1. With a confidence probability of 0.95, calculate the confidence interval, if the diameter of the arterioles took the following values
2. Formulate a conclusion.

№ п/п	$Д_i$ *(мкм)*	$\Delta Д_i = \lvert\overline{Д} - Д_i\rvert$	$\Delta Д_i^2$	**σ, m**	$t_{0,95;n-1}$	**E%**	Доверительный интервал Δt
1	21						
2	24						
3	29						
4	30						
5	27						
	$\overline{Д}=$	$\Delta\overline{Д}=$	$D=$				

Conclusion:

:

4. METHODOLOGICAL MATERIALS DETERMINING PROCEDURES FOR ASSESSING KNOWLEDGE, ABILITIES, SKILLS AND (OR) ACTIVITY EXPERIENCE CHARACTERIZING THE STAGES OF COMPETENCY FORMATION.
DESCRIPTION OF INDICATORS AND CRITERIA FOR ASSESSING COMPETENCIES, DESCRIPTION OF ASSESSMENT SCALES

SCALE FOR EVALUATION OF PRACTICAL (LABORATORY) WORKS
(current/terminal control)

• 85-100% - A student demonstrates complete understanding of the problem. All requirements for the assignment are met.
• 70-84% - A student demonstrates significant understanding of the problem. All requirements for the assignment have been met.
• 60-69% - A student demonstrates a partial understanding of the problem. Most of the requirements for the task are met.
• 31-60% - A student demonstrates little understanding of the problem. Many requirements for the assignment were not met.
• 0-30% - A student demonstrates a lack of understanding of the problem and no attempt has even been made to solve the problem.

SCALE FOR ASSESSING ANSWERS TO CONTROL QUESTIONS
(current control)

• 85-100% - A student demonstrates complete understanding of the problem. All tasks completed.
• 70-84% - A student demonstrates significant understanding of the problem. All tasks are completed, but contain some inaccuracies.
• 60-69% - A student demonstrates a partial understanding of the problem. Most of the requirements for the assignment have been met.
• 31-60% - A student demonstrates little understanding of the problem. Many requirements for the assignment were not met.
• 0-30% - A student demonstrates a lack of understanding of the problem or no answer, and there was not even an attempt to solve the problem.

WRITTEN SURVEY SCALE
(intermediate control - "KNOW")

• A mark (14-16 - points) evaluates the answer, which shows a solid knowledge of the theoretical foundations of the discipline, understanding and correct use of terminology, correct answers to 75-100% of questions
• A mark (11-13 points) evaluates the answer, which shows knowledge of the theoretical foundations of the discipline, but incomplete understanding and not always correct use of terminology, correct answers were given to 50-74% of questions, a number of inaccuracies were made in the answers.
• A mark (8-10 points) evaluates the answer, indicating familiarity with some of the theoretical foundations of the discipline. Correct answers were given to 25-49% of questions, inaccuracies and mistakes were made.
• A mark (5-7 points) evaluates the answer, revealing ignorance of the theoretical foundations of the discipline. There is a lack of logic and consistency in the answer. Less than 25% correct answers. Serious errors were made in the content of the answer.
• A mark (0-4 points) evaluates the answer, in which the student demonstrates a lack of understanding of the questions, or no answer.

SCALE OF EVALUATION OF THE SUMMARY

• 85-100% - the student has deeply and comprehensively mastered the problem; - confidently, logically, consistently and competently sets it out; - relying on the knowledge of the main and additional literature, closely links the acquired scientific provisions with practical activities; - skillfully substantiates and argues the ideas put forward by him; - draws conclusions and generalizations; - fluent in concepts
• 70-84% - the student has firmly mastered the topic, correctly and to the point sets it out, relying on knowledge of the main literature; - does not allow significant inaccuracies; - links acquired knowledge with practical activities; - argues scientific provisions; - draws conclusions and generalizations; - owns a system of basic concepts
• 60-69% - the topic is not disclosed clearly enough and fully, that is, the student has mastered the problem, essentially sets it out, relying on knowledge of only the main literature; - allows minor errors and inaccuracies; - experiences difficulties in the practical application of knowledge; - weakly argues scientific positions; - finds it difficult to formulate conclusions and generalizations; - partially owns the system of concepts
• 31-60% - the student demonstrates little understanding of the problem. Many job requirements not met
• 0-30% - the student did not master a significant part of the problem; - allows significant errors and inaccuracies when considering it; - experiencing difficulties in the practical application of

knowledge; - cannot argue scientific positions; - does not formulate conclusions and generalizations; - does not own the conceptual apparatus

ASSESSMENT SCALE FOR PRACTICAL ASSIGNMENTS AND SIW (intermediate control - "TO BE ABLE AND TO MASTER")

• A mark (8-9 points) evaluates the answer, in which the student correctly solves individual problems in mathematics and medical biophysics. Demonstrates a thorough understanding of the problem. All job requirements have been met.
• A mark (6-7 points) evaluates the answer, in which the student mostly correctly solves individual problems in mathematics and medical biophysics. Demonstrates significant understanding of the problem. Most of the job requirements have been met.
• A mark (4-5 points) evaluates the answer, in which the student solves individual problems in mathematics and medical biophysics incorrectly, demonstrates the inability to correctly solve the problem from the individual task. Demonstrates partial or little understanding of the problem. Many of the requirements for the assignment are not met.
• A mark (0 -3 points) marks the answer, in which the student demonstrates a lack of understanding of the problem or no answer, and there was not even an attempt to solve the problems.

5. METHODOLOGICAL INSTRUCTIONS FOR STUDENTS ON MASTERING DISCIPLINE/PRACTICE AND COMPLETING CONTROL TASKS

Guidelines for independent extracurricular work of students to study the theoretical foundations of the discipline "physics, mathematics".

The study of the theoretical part of the discipline is designed to not only deepen and consolidate the knowledge gained in the classroom, but also to promote the development of students' creative skills, initiative and organization of their free time. Independent work of the student in the study of the discipline includes:
- reading the recommended literature and mastering the theoretical material of the discipline;
- familiarity with Internet sources; - preparation for various forms of control (control work, test);
- work on the creation of a protocol for laboratory work.
Planning the time required to study the discipline, students are better to carry out the entire semester, while providing for regular repetition of the material.
The material outlined in the lectures should be regularly studied and supplemented with information from other sources of literature presented not only in the discipline program, but also in periodicals.
When studying the discipline it is necessary for each topic to read the recommended literature and make a brief summary of the main provisions, terms, information that require memorization and are fundamental to this topic, for the development of subsequent topics of the course. To expand knowledge of the discipline, it is recommended to use Internet resources; conduct searches in various systems and use the materials of sites recommended by the teacher.

CONTROL WORK In preparation for the decision of the control work is necessary:
- to work out the relevant pages of textbooks;
- use lecture notes or notes from practical material;
- solve as much as possible the problems at home on relevant topics.

LABORATORY WORK In preparation for the laboratory work it is necessary to:

- to work out the theoretical material from the textbooks;
- conduct a test of self-knowledge;
- prepare a protocol for laboratory work;
- perform laboratory work and submit a report including mathematical processing of experimental data and their analysis

TEST

In preparation for the tests, it is necessary to work out the lecture material and the relevant pages of textbooks (it is also desirable to
read additional literature); solve all the necessary practical tasks; perform all the necessary laboratory work

ESSAY

Students do work on the essay individually, on their own with the aim of consolidating and deepening of theoretical knowledge. The topic of the abstract and the proposed work plan is discussed with the teacher, and then the student independently selects, analyzes and structures the material. The approximate volume of the abstract – 10-15 sheets of printed text, welcome the use of diagrams, drawings, tables, complementing the main material. The work should contain the purpose, objectives of the study, and generalized conclusions on the problem. In the structure of the abstract, there is a title page, designed according to the requirements, table of contents, introduction, main part, final, list of used literature and Internet resources. The abstract should be submitted to the teacher for review within the specified time, after correcting the material comments (if any), the student can proceed to presentation at the appointed time.