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

2024

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; - oral survey
	To be able: - 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; - laboratory works executing; - control work, 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. - essay

2. TECHNOLOGICAL MAP OF THE DISCIPLINE

Technological map of the discipline "Medical biophysics"
Course 1, Semester 1, 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. Elements of Higher Matemathics	Current control	Activity, attendances; Independent work	4 5	8 9	8
	Frontier control	Control work №1 on Math	12	16	
Module 2					
Section 2. Medical Physics	Current control	Activity, attendances; Independent work	4 5	8 9	15
	Frontier control	Lab reports, tests Essay	6 4	10 9	
TOTAL in semester			40	70	16
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. 1.1 Test tasks in mathematics

Question 1. The order of the differential equation is determined by:
1. the order of the derivative included in this equation;
2. the order of the differential included in this equation;
3. the highest order of derivative included in this equation;
4. smallest order of derivative in this equation

Question 2. The solution to a differential equation is:
1. any function;
2. any function whose derivative is 0;
3. any function whose derivative is other than 0;
4. any function, substituting which equation in a given equation turns into an identity
5. any function whose differential is different from unity.

Question 3. Indicate the general form of the differential equation:
1. $F(x, y) = 0$
2. $F(x, y') = 0$
3. $F(x, y, y'') = 0$
4. $\frac{d\vartheta}{dt} = mg$
5. $F(x, y, y', y'', ..., y^{(n)}) = 0$

Question 4. Indicate the general form of the complete differential equation of the second order:
1. $F(x, y, y', y'') = 0$
2. $F(y, y', y'') = 0$
3. $F(x, y', y'') = 0$
4. $F(x, y, y') = 0$
5. $F(x, y, y', y'', y''') = 0$

Question 5. Indicate the general solution of the differential equation

$$dy = (x^5 - 7)dx$$

1) $y = \frac{x^6}{6} - 7 + c$
2) $y = \frac{x^6}{6} - 7x + c$
3) $y = 5x^4 - 7x + c$
4) $y = x^6 - 7x + c$

Question 6. Indicate the general and particular solutions of the differential equation

$y' = \sin x$, при $x = 0, y = 2$

1) $y = -\cos x + c;\ y = -\cos x + 3$
2) $y = \cos x + c;\ y = cosx + 1$
3) $y = cosx + c;\ y = cosx + 4$
4) $y = cosx + c;\ y = cosx + 2$

Question 7. Indicate the general and particular solutions of the differential equation

$dy = cosxdx$, при $x = \frac{\pi}{2};\ y = 3$

1) $y = -sinx + c;\ y = -sinx + 4$
2) $y = sinx + c;\ y = sinx + 4$
3) $y = sinx + c;\ y = sinx + 5$
4) $y = sinx + c;\ y = sinx + 2$

Question 8. Indicate the general solution of the differential equation

$$y' = 2x^5 - 1$$

1) $y = 10x^4 + c$
2) $y = \frac{1}{3}x^6 - x + c$
3) $y = \frac{1}{3}x^6 + c$
4) $y = x^6 - x + c$

Question 9. Indicate the general solution of the differential equation

$$y' = 3x + 7$$

1) $y = 3 + 7x + c$
2) $y = \frac{3}{2}x^2 + 7 + c$
3) $y = 3\frac{x^2}{2} + 7x + c$
4) $y = 3x^2 + 7x + c$

Question 10. Indicate the general solution of the differential equation

$$y' = 2x^5 - 1$$

1) $y = 10x^4 + c$
2) $y = \frac{1}{3}x^6 - x + c$
3) $y = \frac{1}{3}x^6 + c$
4) $y = x^6 - x + c$

Question 11. In the law of radioactive decay: $N = N_0 e^{-\lambda t}$ what means the minus sign:
1. the number of radioactive nuclei remains constant;
2. the number of radioactive nuclei decreases over time;
3. the number of radioactive nuclei increases over time;
4. The number of radioactive nuclei decreases until a certain time, and then increases.

Question 12. The probability of the sum of two compatible events is:
1.P (A or B) = P (A) + P (B) - P (A and B)
2. P (A or B) = P (A) + P (B) + P (A and B)
3.P (A or B) = P (A) + P (B)

4.P (A or B) = P (A) + P (B) * P (B / A)

Question 13. The probability of the sum of two incompatible events is:

1.P (A or B) = P (A) + P (B) -P (A) * P (B)

2.P (A or B) = P (A) + P (B) + P (A) * P (B)

3.P (A or B) = P (A) + P (B)

4.P (A or B) = P (A) + P (B) * P (B / A)

Question 14. Indicate what is the sum of the probabilities of two opposing events:

1) 1
2) 0
3) -1
4) 0,5

Question 15. Indicate the formula for the classical definition of the probability of a random event A (n is the total number of outcomes; m is the number of favorable outcomes for event A).

1. $P(A)=\frac{n}{m}$
2. $P(A)=\lim_{n\to\infty}\frac{m}{n}$
3. $P(A)=\frac{m}{n}$
4. $P(A)=\lim_{n\to 0}\frac{m}{n}$

Question 16. Events are called joint if:

1. the onset of one of the events in one experiment does not exclude the appearance of another
2. the onset of one of them in one experiment is necessarily accompanied by the onset of the other
3. Under the conditions of experience, only these events will occur and no other
4. if events cannot occur simultaneously in the conditions of a given experience

Question 17. For the exam, the student learned 20 tickets out of 30. Find the probability that he will get an unlearned ticket:

1) 1/3
2) 2/3
3) 9/29
4) 20/29

Question 18. The probability of receiving at least one doctor's call within an hour is 0.85. Find the probability that no calls will follow within an hour:

1) 0.85
2) 0.15
3) 0.3
4) 0.45

Question 19. Find the likelihood that in a family with three children all three sons (assume that the probability of having a boy is 0.515):

1) 1.545
2) 0.515
3) 0.136
4) 0.176

Question 20. When determining the blood group, it turned out that group I was in 24.1% of the population, group I was in 36.9%, group III was in 20.2% of the population, group IV was in 18.8%. Find the probability that a blood group is randomly taken from a donor:

a) I or II,
b) II or III,
c) I or III,
d) III or IV
1. a) 61%, b) 57.1%, c) 44.3%, d) 39%
2. a) 8.9%, b) 7.5%, c) 4.9%, d) 3.8%
3. a) 52%, b) 47%, c) 33%, d) 30%
4. a) 70, b) 65, c) 53, d) 40

Question 21. During the flu epidemic, out of 20 people who were taken to hospital with injuries, 4 were sick with the flu. 3 people are placed in the ward. Find the likelihood that everyone in the room is sick with the flu.
1. 0,53
2. 0,0035
3. 0,47
4. 0,30

Question 22. The student came to the exam, knowing the answers to 80 of 135 exam questions. There are 4 questions on the ticket. Determine the likelihood that the student will answer all questions on the ticket.
1) 2.35
2) 0.13
3) 0.88
4) 0.75

Question 23. Of the examined 10,000 people, 37% had a I blood type, 24% had a II group, 22% had III group, and 17% had a IV blood group. Find the likelihood that an arbitrary blood group is taken from an arbitrary donor taken from this group of examined patients:
a) I or II, b) II or III, c) III or IV.

1.	2.	3.	4.
61%,	0,09	59%	0,08
46%	0,05	39%	0,04
39%	0,03	54%	0,06

Question 24. The probability of which event is 1?
1. reliable
2. impossible
3. random

Question 25. The probability of which event is 0 ?
1. reliable
2. impossible
3. random

Question 26. The random variable is:
1. the value, which as a result of experience can take one or another value, it is not known in advance which one
2. the value, which as a result of experience can take one or another value, it is known in advance which one
3. a value that, as a result of an experiment, can take on a value only in the range from 0 to 1
4. randomly selected value

Question 27. The table that lists the possible values of the random variable and the corresponding probabilities is called:
1. distribution function of a random variable
2. distribution density of a random variable
3. range of the distribution of a random variable
4. variance of random variable

Question 28. A function of the form F (x) = P (X <x), where X is a random variable, is called:
1. probability distribution function of a random variable

2. probability density of a random variable
3. range of the distribution of a random variable
4. variance of random variable

Question 29. The probability distribution function of a random variable can take values lying in the interval:

1.from - ∞ to + ∞
2. from -1 to 0
3. 0 to + ∞
4. 0 to 1

Question 30. Dispersion characterizes:

1. smallest value of a random variable
2. average value of a random variable
3. degree of dispersion of a random variable relative to its mathematical expectation
4. degree of scattering of a random variable relative to its mode

Question 31. The variance of a discrete random variable is calculated by the formula:

1. $D(x)=\int_{-\infty}^{\infty} xf(x)dx$
2. $D(x)=\int_{-\infty}^{\infty}[x-M(x)]^2 f(x)dx$
3. $D(x)=\sum_{i=1}^{n}[x_i-M(x)]^2 P_i$
4. $D(x)=\sum_{i=1}^{n} x_i \cdot P_i$

Question 32. The variance of a continuous random variable is calculated by the formula:

1. $D(x)=\int_{-\infty}^{\infty} xf(x)dx$
2. $D(x)=\int_{-\infty}^{\infty}[x-M(x)]^2 f(x)dx$
3. $D(x)=\sum_{i=1}^{n}[x_i-M(x)]^2 P_i$
4. $D(x)=\sum_{i=1}^{n} x_i \cdot P_i$

Question 33. The most likely value of a random variable is called:

1. the mathematical expectation of a random variable
2. standard deviation of a random variable
3. fashion random variable
4. median random variable

Question 34. Match values in Gauss law

$$f(x)=\frac{1}{\sigma\sqrt{2\pi}}\cdot e^{-\frac{(x-M(x))^2}{2\sigma^2}}$$

1) σ; 2) $M(x)$; 3) x; 4) $f(x)$

a) expectation
b) standard deviation
c) probability density distribution function
d) random variable

Question 35. The mathematical expectation of a random variable is called:

1. the sum of the products of all possible values of a random variable by the corresponding probabilities
2. square root of the variance
3. the set of all values of this quantity with corresponding probabilities
4. the sum of the square of the products of all possible values of a random variable by the corresponding probabilities

Question 36. The mathematical expectation of a discrete random variable is calculated by the formula:

1. $M(x)=\int_{-\infty}^{\infty} xf(x)dx$
2. $M(x)=\int_{-\infty}^{\infty}[x-D(x)]^2 f(x)dx$
3. $M(x)=\sum_{i=1}^{n}[x_i-D(x)]^2 P_i$
4. $M(x)=\sum_{i=1}^{n} x_i \cdot P_i$

Question 37. The mathematical expectation of a continuous random variable is calculated by the formula:

1. $M(x)=\int_{-\infty}^{\infty} xf(x)dx$
2. $M(x)=\int_{-\infty}^{\infty}[x-D(x)]^2 f(x)dx$
3. $M(x)=\sum_{i=1}^{n}[x_i-D(x)]^2 P_i$
4. $M(x)=\sum_{i=1}^{n} x_i \cdot P_i$

Question 38. The standard deviation of a discrete random variable is calculated by the formula:

1. $\sigma(x)=\sqrt{\int_{-\infty}^{\infty} xf(x)dx}$
2. $\sigma(x)=\sqrt{\int_{-\infty}^{\infty}[x-M(x)]^2 f(x)dx}$
3. $\sigma(x)=\sqrt{\sum_{i=1}^{n}[x_i-M(x)]^2 P_i}$
4. $\sigma(x)=\sqrt{\sum_{i=1}^{n} x_i \cdot P_i}$

Question 39. The standard deviation of a continuous random variable is calculated by the formula:

1. $\sigma(x)=\sqrt{\int_{-\infty}^{\infty} xf(x)dx}$
2. $\sigma(x)=\sqrt{\int_{-\infty}^{\infty}[x-M(x)]^2 f(x)dx}$
3. $\sigma(x)=\sqrt{\sum_{i=1}^{n}[x_i-M(x)]^2 P_i}$
4. $\sigma(x)=\sqrt{\sum_{i=1}^{n} x_i \cdot P_i}$

Question 40. Set the correspondence between the characteristics of random variables and their mathematical expressions:

1. $M(x) = \sum_{i=1}^{n} x_i \cdot P_i$
2. $D(x) = \sum_{i=1}^{n} [x_i - M(x)]^2 P_i$
3. $M(x) = \int_{-\infty}^{\infty} xf(x)dx$
4. $D(x) = \int_{-\infty}^{\infty} [x - M(x)]^2 f(x)dx$

a) the variance of a discrete random variable
b) the variance of a continuous random variable
c) mathematical expectation of a discrete random variable
d) mathematical expectation of a continuous random variable

Question 41. The sample population differs from the general one:
1. different units of measurement of observed objects
2. different volumes of direct observation units
3. a different number of recorded observations
4. different ways of registering observation units

Question 42. Duplicate sample values in ascending order are called:
1. random sampling
2. the general population
3. Statistical row
4. variation range

Question 43. A polyline whose segments connect the points with the coordinates is called:

x	x_1	x_2	…	x_i	…	x_k
m	m_1	m_2	…	m_i	…	m_k
P^*	P_1^*	P_2^*	…	P_i^*	…	P_k^*

1. polygon frequency
2. frequency range polygon
3. range of relative frequencies
4. frequency polygon

Question 44. The range of possible values of the desired parameter, which may be with some probability of its value, is called:
1. confidence interval
2. variation interval
3. correlation interval
4. representative interval

Question 45. The linear correlation coefficient can take values:
1.from - ∞ to +∞
2. from -1 to 0
3. 0 to 1
4.from -1 to +1

Question 46. Match:
1. r = -0.3
2. r = 0.6
3. r = -0.8
4. r = 0.8
5. r = 0.3

a) the relationship between X and Y is strong, increasing

b) the relationship between X and Y is weak, increasing
c) the dependence between X and Y is strong, decreasing
d) the relationship between X and Y is weak, decreasing
e) the relationship between X and Y is medium, increasing
Question 47. Identify a random event whose probability is zero:
a) impossible;
b) certain;
c) opposite;
d) incompatible;
d) equally probable.
Question 48. Identify a random event whose probability is one:
a) impossible;
b) certain;
c) opposite;
d) incompatible;
d) equally probable.
Question 49. Indicate which events are called joint?
a) the occurrence of one event in one experiment does not exclude the occurrence of the other;
b) the occurrence of one event in one experiment is necessarily accompanied by the occurrence of the other;
c) under the conditions of the experiment, only these events and no others will occur;
d) if events cannot occur simultaneously under the conditions of a given experiment;
d) the occurrence of one event in one experiment excludes the occurrence of the other.
Question 50. Which of the following events does not exist from the perspective of probability theory?
a) Certain events;
b) Impossible events;
c) Decisive events;
d) Random events;
d) Opposite events.
Question 51. Indicate which events are called the only possible ones:
a) if, under the conditions of a given experiment, only these events and no others will occur;
b) if the occurrence of one event in one experiment excludes the occurrence of another;
c) if events cannot occur simultaneously under the conditions of a given experiment;
d) the occurrence of one event in one experiment does not exclude the occurrence of another;
d) if the occurrence of one event in one experiment is necessarily accompanied by the occurrence of the other.
Question 52. Define what is meant by a random event?
a) an event that may or may not occur as a result of an experiment;
b) an event that must occur;
c) an event that is currently occurring;
d) an event that will never occur;
d) an event that has already occurred.
Question 53. Define the probability of a random event.
a) it is the ratio of the total number of possible outcomes to the number of favorable outcomes;
b) it is the total number of observations;
c) the number of observations of a given event in an experiment;
d) it is a numerical measure of the degree of objective probability of this event;
d) a qualitative characteristic of a random event.
Question 54. Indicate what values the probability of a random event can take.
a) from -1 to 0;
d) from 0 to +;

b) from 0 to 1;
c) from
to
d) from -1 to +1;
Question 55. Indicate which events are called mutually exclusive.
a) no two of them can appear together;
b) events always appear only together;
c) the occurrence of one of them changes the probability of the other;
d) the probabilities of these events are negative;
d) the probabilities of these events are equal to one.
Question 56. Indicate which events are called equally likely:
a) no two of them can appear together;
b) the events always appear only together;
c) the occurrence of one of them changes the probability of the other;
d) the probabilities of these events are equal to one;
d) the probabilities of these events are equal to one.
Question 57. Indicate which events are called opposite:
a) the sum of the probabilities of these events is greater than one;
b) the events can appear together;
c) one event consists of the non-occurrence of the other;
d) the occurrence of one of them does not change the probability of the other;
d) the sum of their probabilities is zero.
Question 58. Indicate which events are called independent:
a) the events cannot appear together;
b) the events only occur separately;
c) the events always occur only together;
d) the occurrence of one of them does not change the probability of the other;
d) one event consists of the non-occurrence of the other.
Question 59. Determine what the probability of event A, calculated given that event B has occurred, is called.
a) the conditional probability of event B;
b) the conditional probability of the difference between events A and B;
c) the conditional probability of the product of events A and B;
d) the conditional probability of event A;
d) the conditional probability of event A.
Question 60. Explain the meaning of a random variable:
a) a variable that, as a result of an experiment, can take on a strictly fixed value;
b) a variable that, as a result of an experiment, can take on one or another value, the exact value being known in advance;
c) a variable that, as a result of an experiment, can only take on a value in the interval from 0 to 1;
d) a variable that, as a result of an experiment, can only take on a value in the interval from -1 to 1.
e) a variable that, as a result of an experiment, can take on one or another value, the exact value being unknown in advance.
Question 61. Select the correct answer. The sum of two events A and B is event C, which consists of:
a) the non-occurrence of event B and the occurrence of event A.
b) the occurrence of either event A or event B;
c) the simultaneous occurrence of events A and B;
d) the exclusion of event A and event B;
d) the non-occurrence of event A and the occurrence of event B;
Question 62. Select the correct answer. The product of two events A and B is event C,

which consists of:
a) the exclusion of event A and event B;
b) the occurrence of either event A or event B;
c) the simultaneous occurrence of events

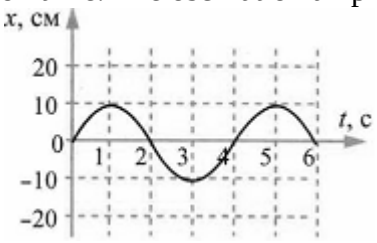
A. 1.2. Тестовые задания к лабораторным работам по физике

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.

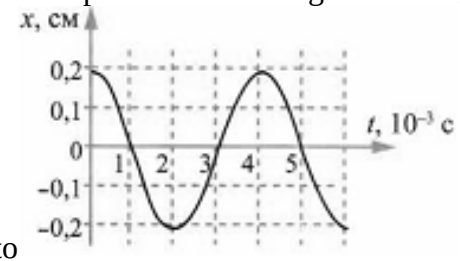
TEST TASKS (EXAMPLES)

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.

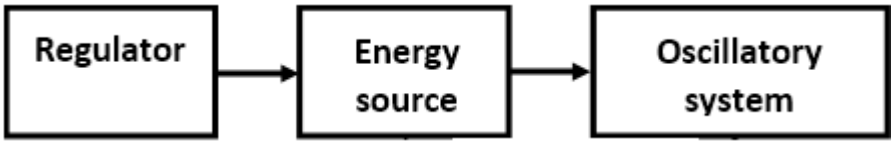
11. Indicate the formula by which the amplitude of the damped oscillation is determined at any time ***t***:
a) $A_t = \pm A_0 e^{-\beta t}$;
b) $A_t = \pm A e^{-\beta t}$;
c) $A_t = A_0 e^{-\beta t}$;
d) $A_t = A_0 e^{-t}$.

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.

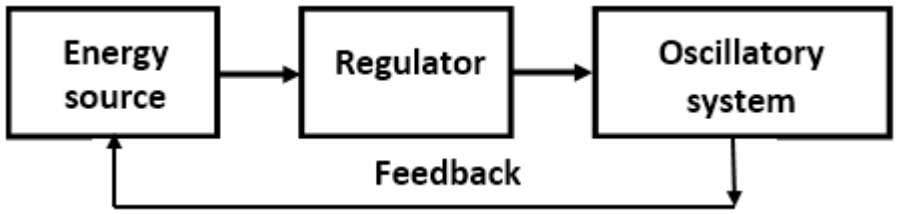
16. Indicate the block-scheme according to which self-oscillations are carried out:
a)

b)

c)



d)



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

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

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

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;

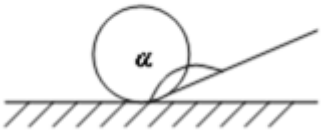
b) gravitational forces;

c) nuclear interaction forces;

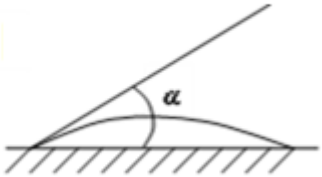
d) forces of intermolecular attraction.

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

a)



c)



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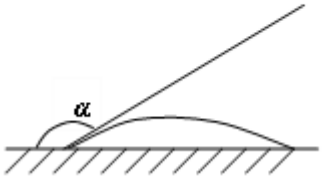
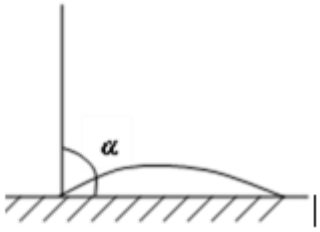


d)



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;

$\boldsymbol{\rho_{ж}}$ - liquid density;

$\boldsymbol{\vartheta}$ is the average flow velocity over the pipe section;

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

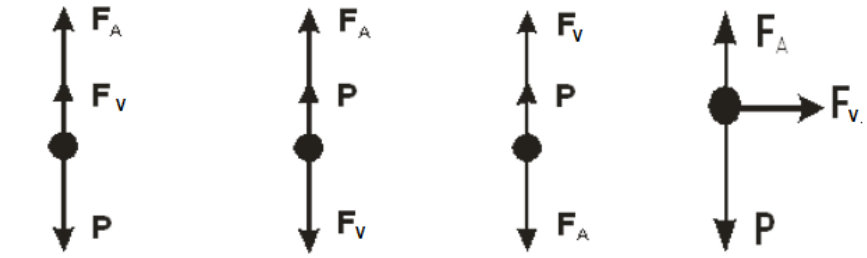
Here $\frac{\vartheta_2 - \vartheta_1}{z_2 - z_1} = grad\,\vartheta$ is flow velocity gradient,

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

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:

a) b) c) d)



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.

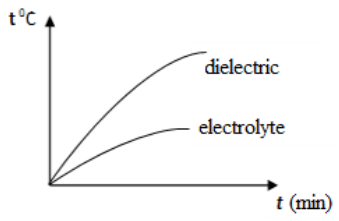
LAB № 4. STUDYING THE ACTION OF ULTRA-HIGH-FREQUENCY (UHF) ELECTRIC FIELD ON SUBSTANCE

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.

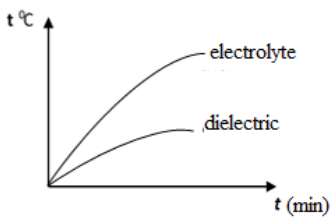
TEST TASKS (EXAMPLES)

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)



b)



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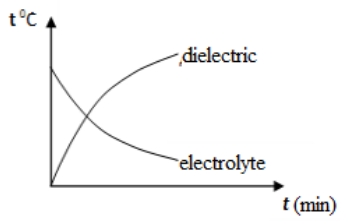

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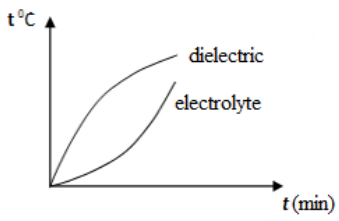
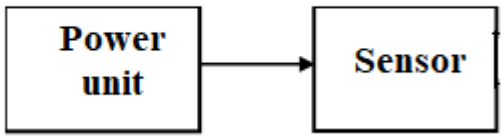


2. Indicate the block diagram of the UHF therapy device:

a)



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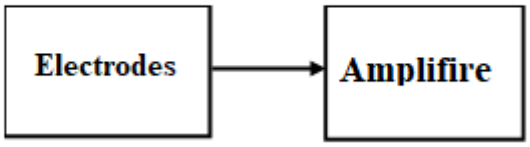
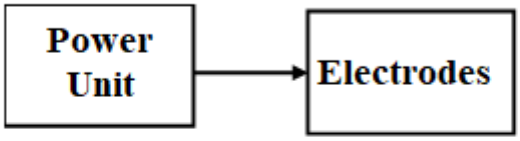
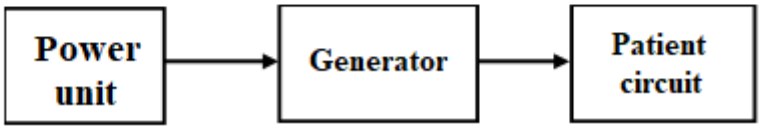


c)



d)



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

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

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

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) $\vec{Д} = \vec{I} \cdot S$;

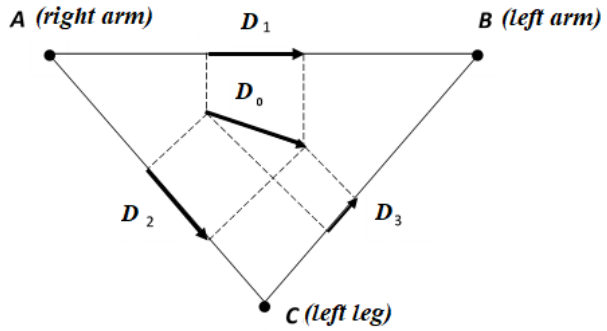
b) $\vec{Д} = \vec{I} \cdot l$;

c) $\vec{I} = \vec{Д} \cdot l$

d) $\vec{Д} = \frac{\vec{I}}{l}$

25. Specify Einthoven's triangle and its leads:

a)



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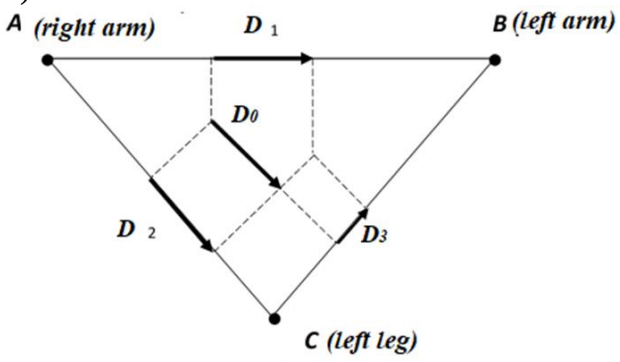
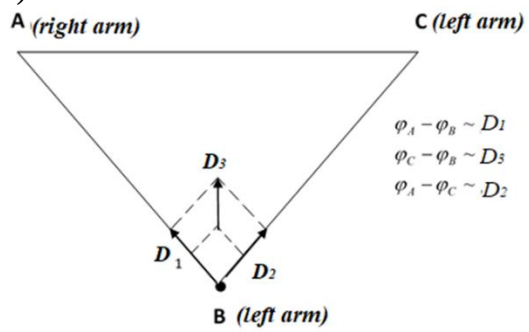


c)



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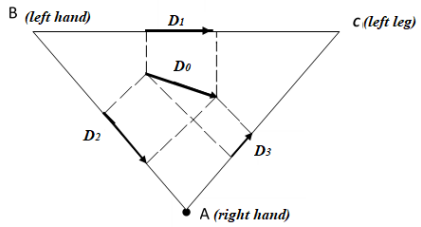


32. Indicate the model of the equivalent current electrical generator of a cell located in a volumetric electrically conductive medium: where

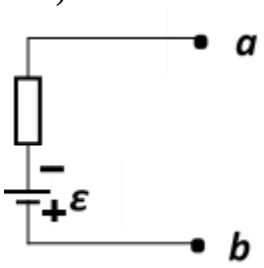
R is the intracellular current resistance;

R_0 is the resistance of the environment;

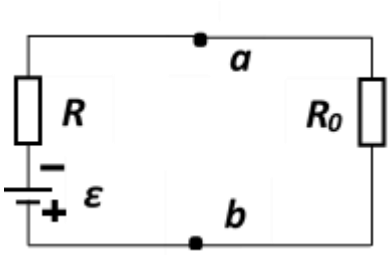
ε - EMF of the generator;

a, b – generator poles.

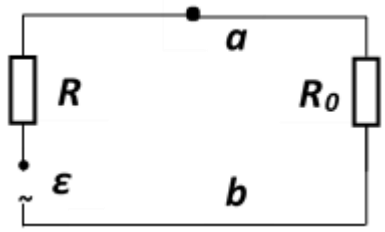
a)



b)



c)



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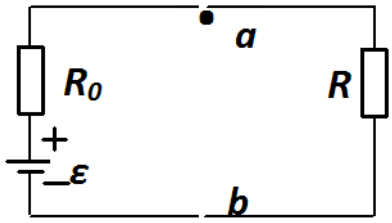


LAB № 6. REFRACTO INDEX DETERMINATION OF LIQUIDS USING A REFRACTOMETER

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) $\frac{M}{c}$; c) s^{-1}.

5. The formula for the absolute refractive index is:

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

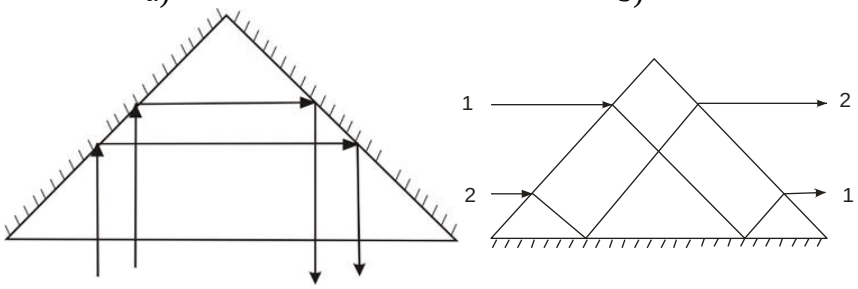
b) $n_0 = \frac{\vartheta_1}{\vartheta_2}$;

c) $n_0 = \frac{C}{\vartheta}$;

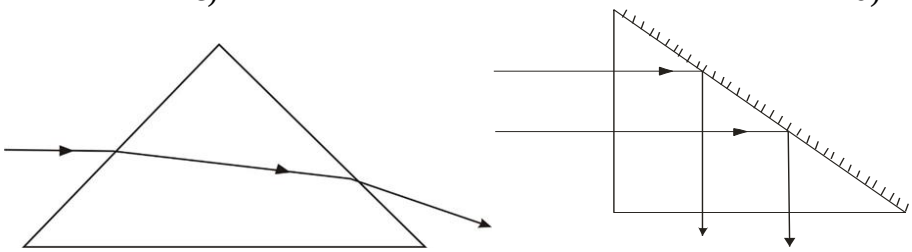
d) $n_0 = \frac{\sin 90^\circ}{\sin \beta_{np}}$.

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.

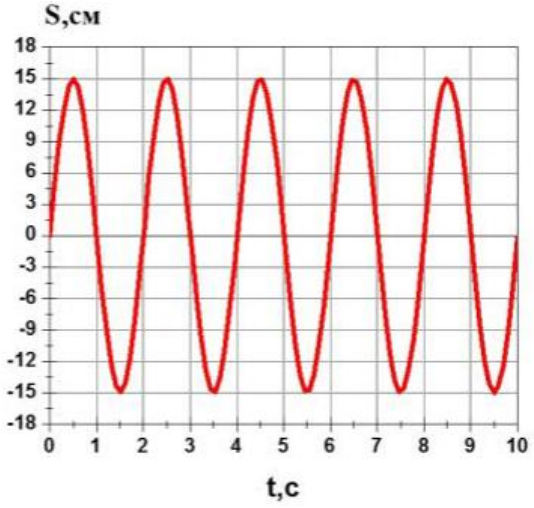
A. 1.3. Physics tests (lecture course)

1. The anisotropy of biological tissues is due to the fact that (you have two correct answers)

a) biological tissue is formed by a combination of chemically dissimilar components;
b) the mechanical properties of biological tissue differ from the mechanical properties of each of its individual components;
c) biological tissue exhibits both elasticity and rigidity;
d) it exhibits flow properties.
2. What is elasticity?
a) the ability of a material to resist external load;
b) the ability of bodies to regain their size (shape or volume) after the load is removed;
c) the ability of bodies to resist destruction under the action of external forces;
d) the ability of a material to change dimensions under the action of external loads.
3. Define the rigidity of biological tissue:
a) the ability of bodies to resist destruction under the action of external forces;
b) the ability of a material to change dimensions under the action of external loads;
c) the ability of a material to withstand external loads;
d) the ability of a material to change dimensions under the influence of external loads.
4. The strength of biological tissue is
a) the ability of bodies to retain (fully or partially) a change in size after the removal of loads;
b) the ability of bodies to resist destruction under the action of external forces;
c) the ability of bodies to regain their size (shape or volume) after the removal of loads;
d) the ability of a material to deteriorate without the formation of noticeable residual deformations.
5. Elasticity is the ability of biological tissue
a) to deteriorate without the formation of noticeable residual deformations;
b) a dynamic property that allows it to resist changes in shape under the action of tangential stresses;
c) the ability to retain (fully or partially) a change in size after the removal of loads;
d) a dynamic property of tissue that characterizes the ability of its individual layers to move at a certain velocity in space relative to other layers of the same tissue.
6. How is the plasticity of biological tissue manifested?
a) a biological body regains its size (shape or volume) after the removal of loads;
b) a biological body retains (fully or partially) its dimensional change after the load is removed;
c) biological material changes its dimensions under external loads;
d) biological material resists changes in its shape under the action of tangential stresses.
7. When do we speak of the fragility of biological tissue?
a) tissue deteriorates without the formation of noticeable residual deformations;
b) biological material resists changes in its shape under the action of tangential stresses;
c) a biological body regains its dimensions (shape or volume) after the load is removed;
d) a dynamic property of tissue that characterizes the ability of its individual layers to move at a certain velocity in space relative to other layers of the same tissue.
8. Which biological tissue can be called viscous?
a) When it resists changes in shape under tangential stress;
b) When its individual layers move at a certain velocity in space relative to other layers of the same tissue;
c) When its dimensions change under the influence of external loads;

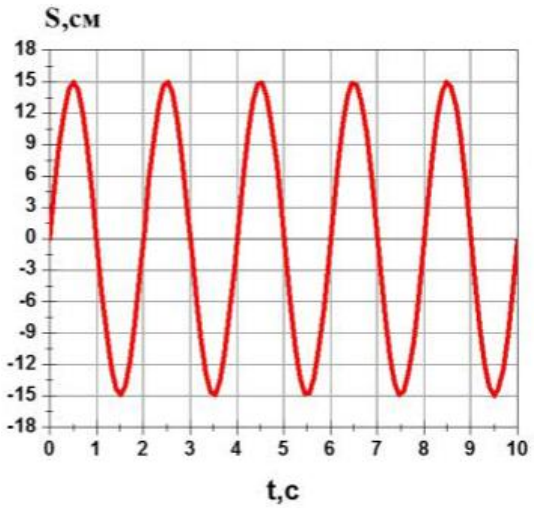
d) Biological tissue resumes its dimensions (shape or volume) after the load is removed.
9. When is biological tissue yielding?
a) When its individual layers move at a certain velocity in space relative to other layers of the tissue;
b) When it resists changes in shape under tangential stress;
c) Biological tissue resumes its dimensions (shape or volume) after the load is removed;
d) When it collapses without the formation of noticeable residual deformations.
10. Which equation describes the position of a body and its support (suspension) at rest?
a) $P = mg$;
b) $P = m(g + a)$;
c) $P = m(g - a)$;
d) $P = m(g – a) = 0$.
11. Which equation describes the position of a body during acceleration or deceleration of high-speed vehicles or during the launch of space rockets?
a) $P = m(g – a)$
b) $P = mg$;
c) $P = m(g + a)$;
d) $P = m(g – a) = 0$.
12. Which equation describes the motion of a body with an acceleration directed vertically downward?
a) $P = m(g + a)$;
b) $P = m(g – a) = 0$;
c) $P = mg$;
d) $P = m(g – a)$.
13. Which equation describes the orbital motion of artificial Earth satellites and space stations when weightlessness occurs?
a) $P = m(g – a) = 0$;
b) $P = m(g – a)$;
c) $P = mg$;
d) $P = m(g + a)$.
14. The propagation of oscillations in an elastic medium is
a) an electromagnetic wave;
b) a mechanical wave;
c) ultraviolet radiation;
d) infrared radiation.
15. One of the conditions (listed below) for the occurrence of harmonic oscillations of a load on a spring is
a) Absence of friction;
b) Absence of elastic force;
c) Absence of all forces;
d) Absence of compression force.
16. A pendulum in a position of equilibrium was disturbed by a blow. The first blow was weak, and the second time, strong. Was the amplitude of the pendulum's oscillations smaller in the first or second case?
a) The amplitude of the pendulum's oscillations remained the same in both cases;
b) In the first case, when the blow was weak;
c) In the second case, when the blow was strong;

d) The amplitude decreased by half.
17. If the heart contracts at a rate of 60 beats per minute, what is the period of contraction?
a) 0.5;
b) 2.0 s;
c) 1.5 s;
d) 1 s.
18. In a transverse mechanical wave, the particles of the medium:
a) are not transported, but only oscillate in a direction perpendicular to the direction of wave propagation;
b) are transported along the direction of wave propagation;
c) are transported perpendicular to the direction of wave propagation;
d) are not transferred, but only oscillate in the direction along the wave propagation direction.
19. The speed of sound in air is 340 m/s, the maximum frequency is 20,000 Hz. What is the minimum wavelength of sound in air?
a) 1176 m;
b) 0.017 m;
c) 0.01176 m;
d) 68 mm.



20. Under real-world conditions, a pendulum oscillates freely. In this case, the amplitude of oscillations at time t + T will be, compared to the amplitude at time t,
a) less
b) the same
c) greater
d) 2.5 times greater

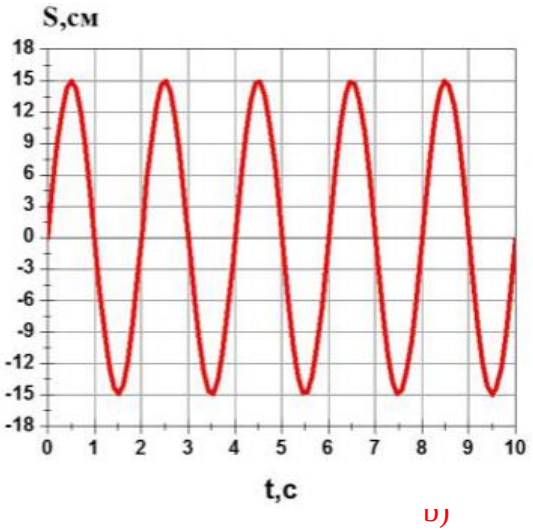
21. The oscillation graph is shown in the figure. What are the oscillation amplitude (A) and oscillation period (T)?
a) A=15 см, T=1 с
b) A=30 см, T=2 с
c) A=15 см, T=2 с
d) A=30 см, T=1 с



22. The oscillation graph is shown in the figure. Write down the law of harmonic oscillations.

a) S(t) = 15sin(t)
b) S(t) = 15sin(t * 3)
c) S(t) = 30 sin(2 t)
d) S(t) = 15sin(2t)

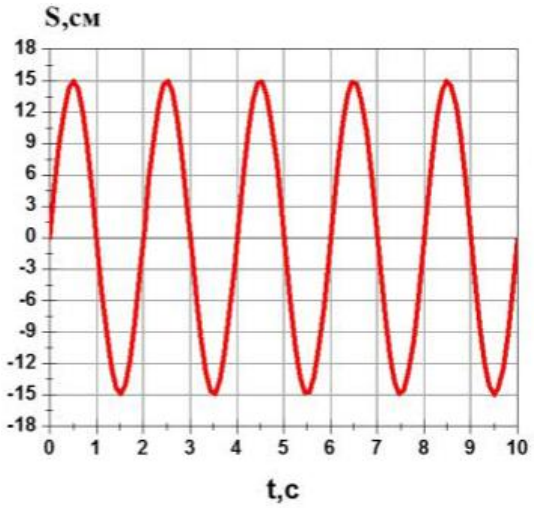
23. The oscillation graph is shown in the figure. What is the oscillation frequency (Hz)?



a) 5 Гц
b) 2 Гц
c) 0,5 Гц
d) 1 Гц

24. The oscillation graph is shown in the figure. What are the oscillation amplitude (A) and oscillation frequency (ν)?

A=30 см, ν = 2 Гц
A=15 см, ν = 0,5 Гц
υ)
c) A=15 см, ν = 5 Гц
d) A=15 см, ν = 2 Гц



25. The oscillation graph is shown in the figure. Write down the law of harmonic oscillations.

$S(t)$ 30 sin(1,5 t)
$S(t)$ 30 sin(t)
$S(t)$ 30 sin(0,5 t / 3)
$S(t)$ 60 sin(0,5 t / 3)

27. The harmonic spectrum of a complex oscillation is shown in the figure. What are the frequencies of the harmonic oscillations into which this complex oscillation is resolved?

а) 2,5; 6
б) 5; 6
в) 2,5; 5
г) 3; 6

28. The oscillation period has increased by a factor of 3. How much will the oscillation frequency change?

a) it will not change
b) it will decrease by a factor of 3
c) it will increase by a factor of 3
d) it will decrease by a factor of 3π

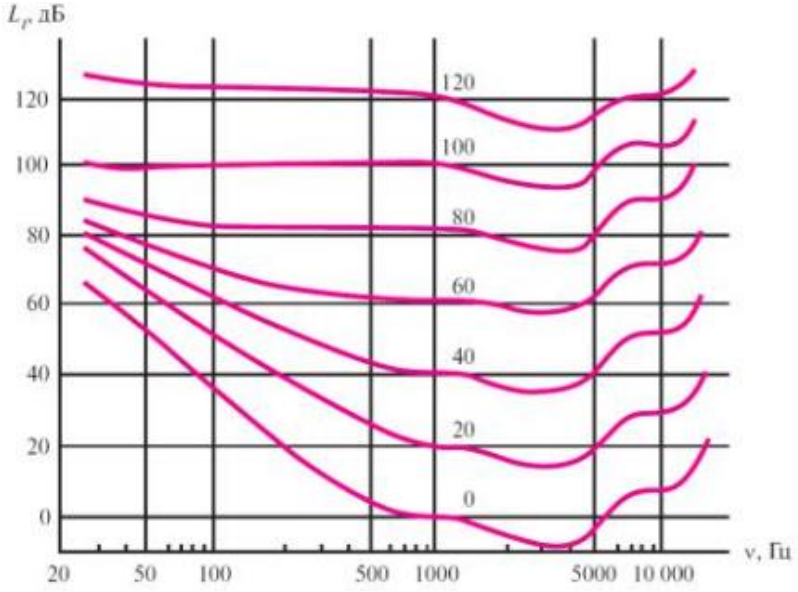
29. The equation $S(t) = A\sin(\omega t + \varphi 0)$ is the equation (two correct answers):

a) of a damped oscillation

b) of a harmonic oscillation
c) of a harmonic wave
d) of any periodic oscillation
30. The frequency of sound is 1000 Hz. Indicate the correct answers (two correct answers):
a) the period of oscillation is 1 s
b) the angular frequency is 6280 rad/s
c) the period of oscillation is 0.001 s
d) the angular frequency is 100 rad/s

Sound

31. Can sound propagate in a vacuum?
a) It can, just like an electromagnetic wave.
b) It can.
c) Sound waves do not propagate in a vacuum.
32. The frequency of a harmonic sound wave increases from 100 Hz to 1000 Hz, while the intensity remains constant. What happens to the loudness?
a) Decreases.
b) Increases.
c) Remains constant.
d) Initially increases, and after reaching a certain maximum value decreases again.
33. Patient A hears a sound at a frequency of 500 Hz better than Patient B. Which patient has a higher hearing threshold at this frequency?
a) Patient A
b) Patient B
c) Their hearing thresholds are the same.
34. The following points are marked on the hearing threshold curve for this person:
1) intensity level LI = 60 dB, frequency 100 Hz;
2) LI = 40 dB, frequency 1000 Hz;
3) LI = 40 dB, frequency 5000 Hz.
Which of the following points does a person hear louder?



a) A person hears all three points equally.
b) Point 1.
c) Point 3.
d) Point 2.

35. Which of the following sound characteristics are physiological (subjective): timbre (1), loudness (2), frequency (3), intensity (4)?

a) 1, 2; b) 1, 4; c) 2, 3; d) 2, 4
36. Which of the following sound characteristics are physical (objective): pitch (1), loudness (2), frequency (3), intensity (4)?
a) 1, 3
b) 3, 4
c) 2, 3
d) 2, 4

Ultrasound

37. The physical nature of ultrasound:
a) mechanical wave
b) ultraviolet radiation
c) electromagnetic wave
d) flow of particles in the medium
38. Which physical characteristics of ultrasound always differ from the characteristics of sound in the same medium?
a) frequency, wavelength
b) propagation velocity, wavelength
c) frequency, amplitude of oscillations
39. Ultrasound examinations use:
a) Mechanical waves with a frequency greater than 20,000 Hz;
b) Electromagnetic waves with a frequency greater than 20,000 Hz;
c) Mechanical waves with a frequency up to 20,000 Hz
40. An ultrasonic wave with an intensity of 0.2 W/cm² is incident on the interface between two media, and the reflected wave intensity is 0.05 W/cm². What is the reflection coefficient?
a) 0.25;
b) 4;
c) 2.5;
d) 0.3.

A 2. **Questions for midterm assessment**

Module 1. MATHEMATICS

MATHEMATICS FUNDAMENTALS

1. Give a definition of the derivative; explain its physical and geometrical meaning. What is a function gradient? What is the direction of a function gradient?
2. What is the physical meaning of the second derivative of way with respect to time?
3. What is an extremum of function? Formulate the stages of the extremum function investigation.
4. Give a definition of the differential of function of one variable. Demonstrate by means of graph a geometrical meaning of differential. Compare differential with a function increment.
5. Give a definition of the partial derivatives. What is their physical meaning?
6. What are partial differentials and total differential of function?
7. Give a definition of the antiderivative function. What is an indefinite integral?

8. Give a definition of the definite integral. What is the geometrical meaning of the definite integral?
9. Explain the Newton-Leibniz rule for definite integral calculation.
10. What is a differential equation? What determines the order of the differential equation? What is the solution of the differential equation?
11. What is a difference between a general solution and a particular solution? How to obtain a particular solution from general one?
12. How to check whether function is a solution of differential equation?

Examples of problems

1) **Find the derivative of ($3x^2 + 4x$)**

Find the derivative of the function $y = \frac{ax+b}{a+b}$, where a and b are constants.

Calculate the derivative of the function $y = 3\sin x + 2\cos x$.

Find the derivative of the function $y = \frac{2}{3x} + 3x^4$.

Calculate the derivative of the function $y = \left(2 - \frac{x}{3}\right)\left(\frac{1}{3} + x^2\right)$.

Find the differential of the function $y = \sin x - x\cos x$.

Find the differential of the function $y = 2x^2 + 3x + 1$ at the point $x = 1$ when $dx = 0,1$

Find the integral of the function $\int 6dx$.
Find the integral of the function $\int 5^x dx$.
Find the integral of the function $\int 5sinxdx$.
Find the integral of the function $\int (2x^3 - 3x^2 + 2x - 7)dx$.
Use the method of substitution to calculate the integral $\int sin^2 x * cosxdx$.
Use the method of substitution to calculate the definite integral $\int_0^1 x(x^2 - 1)dx$.
Use the method of substitution to calculate the definite integral $\int_0^1 \frac{1}{(x+2)^3} dx$.

PROBABILITY THEORY

1. What is a random event? Give a classical and statistical definition of a random event probability.
2. What types of random events do you know?
3. Formulate a probability addition rule. What type of random events can be used for this rule?
4. Which events form the full group of events? What is the sum of probabilities of full group of events?
5. Formulate a probability multiplication rule for independent events.
6. What are independent events? What is a conditional probability?
7. Formulate a probability multiplication rule for dependent events.
8. Present the Bayes formula; interpret a meaning of values in this formula.
9. How can Bayes formula be used for disease diagnostics problems?

RANDOM VARIABLES. DISTRIBUTION OF RANDOM VARIABLES

1. What are the random variables? What are the differences between discrete and continuous random variables? Make examples.

2. How to specify probability distribution for discrete random variable? What is a normalization condition for the distribution for discrete random variable?
3. How to specify probability distribution for continuous random variable? What is a normalization condition in this case?
4. Give a definition of random distribution characteristics: expectation, mode, median, variance, standard deviation. Explain their meaning.
5. How to determine numeric parameters for discrete random variable distribution?
6. How to determine numeric parameters for continuous random variable distribution?
7. What features of continuous random variable normal distribution are known?

Examples of problems

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.

2) 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.

3) 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

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

MATHEMATICAL STATISTICS FUNDAMENTALS

1. Give definition of a general population and a sample. What does representative sample mean? What are the basic requirements for the sample?
2. What are variant, simple statistical series, variational series?
3. What are the stages for variational series (discrete distribution) formation? How can variational series be represented graphically?
4. What are the stages for ranked statistical series (continuous distribution) formation? How ranked statistical series can be represented graphically?
5. Describe the central tendency and the dispersion characteristics for random variables.
6. Explain difference between sample parameters point estimate and sample parameters interval estimate.
7. What is confidence interval finding algorithm?
8. How to determine a required sample volume if the accuracy of interval estimate is known?
9. What is a correlation analysis major task?
10. What is a scatter diagram? What information about parameters correlation does this diagram contain?
11. How to calculate a correlation coefficient between parameters? What information does this coefficient contain?
12. What is the condition of reliable correlation coefficient?

Questions to test the level of training "KNOW":

Topic 1. Error Theory
1.1. What is meant by measuring a physical quantity?
1.2. What is the error of a physical quantity?
1.3. Types of errors (systematic, random, and outliers).
1.4. Statistical characteristics of a sample.
1.5. Absolute and relative measurement errors.
1.6. True value of a physical quantity.

Topic 2. Mechanical Oscillations
- Undamped and damped free mechanical vibrations.
- Attenuation coefficient and logarithmic decrement, the relationship between them. Forced oscillations. Resonance.
- Self-oscillation.

Topic 3. Mechanical waves. Acustics
- 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

Topic 4. Properties of liquids. Surface Fenomena
- 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.

Topic 5.Elements of Biomechanics. Mechanical Properties of Biological Tissues
- Mechanical properties of bone tissue.
- Mechanical properties of blood vessel tissue.
- A definition of a solid body deformation. What is the difference between elastic deformation and plastic one? Specify main types of deformation.
- What is a quantitative measure of deformation? What is the unit of a strain. Give a definition of a stress and indicate its units.
- The Hooke's Law for tension (compression) deformation. What is the relation between stiffness and Young's modulus?
- Plot and analyzis a stress-strain diagram. Determination the proportional limit, elastic limit, yield limit, proof stress and ultimate strength.
- Analyzis the Hooke's Law for shear deformation. What is the Poisson ratio?

Topic 6. Biopotentials
- 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.

Topic 7. Determining the refractive index of liquids using a refractometer
- 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.

Topic 8. X-ray radiation. Elements of nuclear physics
- 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

Block B

B.1. Standard problems

Topic 1. Differentiation and integration

1. 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. $y = x^4 - \ln x + 3^x$.

2. 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.

3. Find full differentials for the following functions:

1. $u = ax^3 + \mathrm{tg}y$.
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. $Q(x,y) = \frac{\pi x^4 P}{8ay}$.

4. 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

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

1. $\int 3x^3 dx.$
2. $\int \frac{dx}{2x^3}.$
3. $\int (4x^3 + 4x - 3)dx.$
4. $\int \frac{dx}{\sqrt{x}}.$
5. $\int (3x^2 + 2x - 1)dx.$
6. $\int \left(\frac{2}{x^2} - \frac{4}{\sqrt{x}} + 3\sqrt[3]{x^2} \right) dx.$
7. $\int x^2(1 - 2x)dx.$
8. $\int (\sqrt{x} + \sin x + e^x)dx.$
9. $\int \frac{\sin 2x}{\sin x} dx.$
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. $\int \frac{2x}{x^2 + 1} dx.$
17. $\int \frac{2dx}{3 - 4x}.$
18. $\int \frac{x^6 dx}{(x^7 - 2)^3}.$

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

Module 2
The textbook (Sologubova T.I., Moldonasirov R.B., Manzhikova S. Ts., Medical Physics. A Manual (англ. яз)for Students of Medical Universities / Bishkek: KRSU, e-LIBRARY.RU, 2025. – 193 p. URL: https://www.elibrary.ru/item.asp?id=82553715 . Date of access 24.02.2026) presents methodological guidelines for laboratory work. For each laboratory work, the following information is provided: purpose, relevance, equipment and accessories, theoretical part, practical part, procedure for completing the experimental portion of the lab. It also provides tables for students to complete after the experiment, plot graphs, and draw conclusions based on the results of the lab work. Questions for midterm assessments and tests are also provided.
B.1. Typical tasks
ASSIGNMENT: Based on the textbook "Medical and Biological Physics" for the lab assignment "Studying Oscillatory Motion Using a Kymograph."
Program for self-training of students.
1. Study theoretically:
- Definitions and units of measurement of the main characteristics of free undamped mechanical oscillations.
- Damped vibrations. Damping decrement, logarithmic damping decrement. Derivation of a formula relating the logarithmic decrement to the oscillation period and damping factor.
- Forced vibrations. Resonance and its importance in medicine.
- Self-oscillations.

2. Preparation of a report by one student from the study group with presentation on the topic "Resonance and its importance in medicine."
3. Master the procedure for performing laboratory work.
4. Prepare a protocol for laboratory work.
5. Self test.

Practical part

Work order

1. Turn on the kymograph, record the equilibrium position.
2. Having deflected the pendulum to the side, release it, simultaneously turning on the stopwatch.
3. After recording the last n-th oscillation, turn off the stopwatch.
4. After the last oscillation, register the equilibrium position and turn off the kymograph.
5. Record graphs of 5 oscillatory processes.
6. Using a ruler for each graph, determine the value of the initial amplitude (A_0) and the last amplitude (A_n).
7. Calculate the number of complete oscillations on the graph (n).
8. Determine the oscillation period T:

$$T = \frac{t}{n},$$

where t is the stopwatch time.

9. Determine the value of the attenuation coefficient by the formula:

$$\beta = \frac{\ln \frac{A_0}{A_n}}{nT}.$$

10. Determine the value of the logarithmic damping decrement:

$$\lambda = \beta T .$$

11. Enter the received data into tables.

№	A_0 (cm)	A_n (cm)	n	t (s)	T (s)	β (s^{-1})	λ
1…							
5							

№ п/п	λ_i	$\Delta\lambda_i = \lvert\overline{\lambda} - \lambda_i\rvert$	$\Delta\lambda_i^2$	σ, m	$t_{0,95;n-1}$	E%	Confidence interval Δt
1							
2							
3							
4							
5							
	$\overline{\lambda} =$	$\Delta\overline{\lambda} =$	$D =$				

ASSIGNMENT: Based on the textbook "Medical and Biological Physics" and the lecture "External Electric Fields of Tissues and Organs" for the lab "Physical Fundamentals of Electrocardiography."

Program for self-training of students.

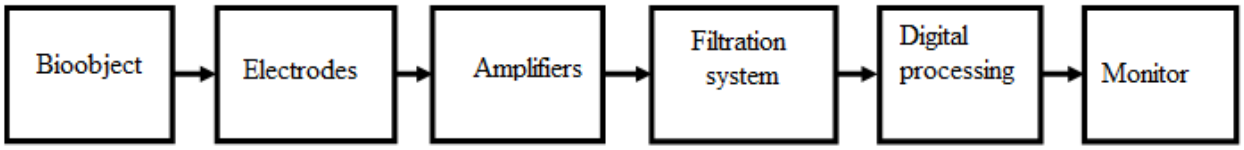
1. Study theoretically:
   - Biophysical principles of research of electric fields of tissues and organs.

- The potential of the electric field created by the unipole and dipole. The concept of a multipole.
- Dipole equivalent electrical generator of the heart.
- Vector electrocardiography. Einthoven's lead theory.
- Block diagram and principle of operation of the electrocardiograph. ECG of a healthy person. Teeth, segments and intervals of the ECG.
- Block diagram of the electrocardiograph. Safety precautions when working with an electrocardiograph.
- Methods of analysis of interval and amplitude parameters of the electrocardiogram.

2. Preparation by one student from the study group of a report with a presentation on the topic “Willem Einthoven. Biography, interesting facts from life.
3. Master the procedure for performing laboratory work.
4. Prepare a protocol for laboratory work.
5. Self-test.

Practical part

Block diagram of an electrocardiograph



Study the Electrocardiograph ЭК1Т-1/3-07 «АКСИОН» ***control panel***
Determin the temporal ECG parameters and values of biopotentials of ECG waves.

1. Get acquainted with the device of the electrocardiograph EK1T-1 / 3-07 "AXION".
2. Moisten the human skin at the places where the electrodes are attached and apply the electrodes in the following order:
   the red - on the right hand;
   the yellow - on the left hand;
   the green - on the left leg;
   the black - on the right leg.
3. Set the speed of the paper tape $\vartheta=25\ \frac{mm}{s}$ (speed adjustment button).
4. Set sensitivity $S=10\ \frac{mm}{mV}$ (calibration button) and record the calibration signal (start button).
5. Record an ECG in the second standard lead (to select a lead, use the right, left buttons).
6. Based on the obtained ECG, determine the length l (mm) of the waves, segments and intervals. Using the formula $t=\frac{l}{\vartheta}$ calculate the duration of waves, segments and intervals in seconds.
7. Find the height h (mm) of the ***P, QRS*** and ***T*** waves. Calculate the value of the corresponding bio potentials using the formula $\Delta\varphi=\frac{h}{S}$ (mV) in millivolts.

Record the obtained data in a table.

Waves, segments,	***l (mm)***		***h (mm)***	

intervals.		$t = \frac{l}{\vartheta}$ (s)		$\lvert\Delta\varphi = \frac{h}{S}$ (mV)
P ***R*** ***T***				
PQ ***ST*** ***TP***				
P-Q ***Q-T*** ***S-T*** ***R-R***				

Block C

C.2. Individual creative tasks

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

35. Physical and mechanical properties of composite materials.
36. Pathogenic effect of radioactive radiation on humans.
37. Age features of the structure of the eye and its appendages.
38. The equivalent electrical circuit of the tissues of the organisms.
39. Tensometry and determination of Poisson's ratio of dental materials.
40. The kinetics of the curing process of the sealing compositions by an ultrasonic method.
41. Application of ultrasound in dentistry.
42. Coefficient of linear and volumetric expansion.
43. Chemiluminometric and their importance in medicine.
44. Biomechatronics is an artificial hand.
45. Nanotechnology in medicine
46. Nanotechnology in Oncology
47. Nanotechnology in dentistry
48. Radiation situation in Kyrgyzstan.
49. Shape memory effect.
50. 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.