State Budgetary Educational Institution of Higher Professional Education of **the Orenburg State Medical University of Ministry of Health of the Russian Federation**

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Workbook for laboratory classes in Biophysics

Studen_____ groups

_____ faculty

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Orenburg 2015

The book is a textbook intended for students of the medical faculty for laboratory practice. In the notebook included questions to prepare for the classes, content, implementation of laboratory works, tests.

Module № 1

Laboratory work №1

Study of an Apparatus for Measuring Blood Pressure

1. Objective:

1. Learn to work with a mechanical device for measuring blood pressure.

2. Instruments:

1. Blood Pressure Meter mechanical.

3. Theoretical introduction

Steady flow of liquid is layered. Stationary or steady a flow called, in which the velocity of particles of the liquid at each point in any time are not changed. Such a flow in which liquid is divided into layers that are moving relative to each other without mixing is called laminar. For such a flow used Bernoulli's equation and Poiseuille.

These equations are formulated for fluid which named an ideal. An ideal fluid is incompressible and has no internal friction or viscosity.

Laminar flow take place in pipes with smooth walls without sharp changes in cross sectional area and bends of the tube, as well as in the absence of multiple branching. When these conditions and especially at high flow velocity, the velocity of particles of fluid are randomly change, formed local twist - the mixing of liquid layers. This flow is neamed turbulent.

Characteristic of turbulent flow are the local variation of pressure in the liquid, causing chaotic oscillatory motion of the particles forming the sound effects (noise, gurgling, etc.), thanks to which the turbulent flow can be easily detected.

The character of the fluid flow through the tube depends on: properties of the fluid, the speed of its flow, pipe size and determined by **Reynolds number-which is a** pipe diameter D is expressed by the following formula:

$$R_e = \rho_{ж} \cdot V \cdot D / \eta$$

where **ρ_{zh}** - density of the liquid,

v- velocity fluid flow,

η- viscosity fluid

If the Reynolds number exceeds a certain critical (Re> Rekr), the turbulent fluid motion take place. For example, for smooth cylindrical tubes $R_{ekr} \approx 2300$, for adult aortic $R_{ecr} \approx 1700\text{-}1900$.

Turbulent flow rate is formed in the vicinity of heart valves, aortic arch and onion in place of branching arteries from the aorta in the abdomen. In other arteries blood flow is laminar.

Turbulence of blood flow in the vessels of the laminar type (brachial artery, femoral artery) can be caused by clamping the artery, in which there is sound (noise) - tone Korotkov.

Korotkov tone usually tapped on the ulnar artery. His appearance and disappearance are the criteria for measuring the systolic and diastolic blood pressure.

Elastic properties of the arteries contribute to smoothing the periodic pressure fluctuations produced by the heart, the continuous flow of blood and more energy efficient at promoting blood.

Blood pressure - the physical parameter. The overall level of blood pressure is caused by several factors:

- the amount of blood flowing in a unit time in the vascular system;
- intensity of the outflow to the periphery;
- the speed of blood flow during systole;
- blood viscosity;
- Values of time systole and diastole;
- heart rate.

Systolic pressure is created from stored energy, which actually has a stream of blood in this portion of the vascular system. Blood pressure on the artery walls when the heart beat is called systolic (upper).

Under the diastolic (minimum) pressure understand that the smallest value, which reaches the end of the blood pressure diastolic period. The blood pressure at the time of expansion is called diastolic heart (bottom).

Systolic blood pressure in normal state (brachial artery) 100-120 mm Hg. Art. During relaxation of the heart (diastole) stretched artery fallen down and the potential energy imparted to them a heart goes into kinetic energy of blood flow, while the diastolic pressure is maintained approximately equal to 60-80 mm Hg. Art.

Among the many problems that arise to modern man due to his state of health, one of the first places occupied by the problems associated with blood pressure. It is widely known that hypertension causes diseases such as cerebral hemorrhage or heart disease. Deviations of the blood pressure from the norm cause numerous diseases and complications.

Blood pressure norms established by the World Health Organization (WHO), can serve as a general guideline:

Pressure (mm Hg. Tbsp.)	**systolic**	**diastolic**
reduced	*less than 100*	*less than 60*
normal	*less than 139*	*less than 89*
border	*140-159*	*90-94*
increased	*more than 160*	*more than 160*

Raising and lowering blood pressure.

In a number of factors that cause high blood pressure, are eating too much salt, overeating, alcohol abuse, smoking, lack of exercise, obesity, fatigue and stress.

It is important to take care of their health by regularly measuring blood pressure and following the recommendations above.

Fluctuations in the value of blood pressure.

Blood pressure fluctuates all the time, so do not be upset or calm down, looking at the results of one or two dimensions. During the day and month of blood pressure is subject to large fluctuations. Great influence on the pressure comes

from even the time of year, ambient temperature, barometric pressure, magnetic storms and other natural phenomena. Moreover, it increases with age. It is therefore important, day after day to control their blood pressure, in order to understand the reasons for its increase or decrease.

When measuring blood pressure often use exercise test.

a) cross-sectional sample. In conducting these trials performed single exercise. Differences related to the type, duration and intensity of the load. Thus, when the sample surveyed Martine performs 20 sit-ups in 30 seconds.

b) 2 sample. Provide re-load with a short interval for rest, during which the reaction is determined by the first load.

Dynamics of heart rate and blood pressure reflects the nature of adaptation to stress the circulatory apparatus. With good functional status of the cardiovascular system is an increase in systolic blood pressure, a slight decrease (less unchanged) and diastolic heart palpitations. Recovery benchmarks completed in 1-3 minutes after small loads and within 3-5 minutes after the big ones.

When measuring blood pressure are in direct and indirect (bloodless) methods.

We give examples of the direct method. Measure of blood pressure can be directly introduced into the vessel through the cannula coupled with a pressure gauge. Such a method is used in animal experiments. In surgery, the pressure measurement in the cavities of the heart produced by catheterization, ie introduction through one of the large vessels thin probe at the end of which is a miniature pressure gauge.

The clinic utilizes indirect (bloodless) method of measuring blood pressure. The most common method of blood pressure measurement Korotkov N. P, based on listening to sounds (Korotkoff) arising in passing the blood through the area of the artery compressed cuff.

This lab contains the blood pressure meter mechanical

a) Description of the instrument (sfigmotonometra) to determine blood pressure.

Exterior view of the device depicted in Figure 1.

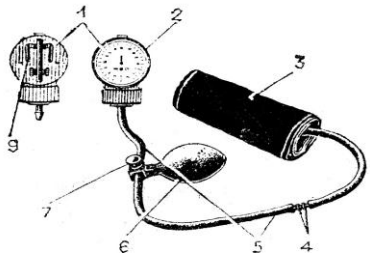


Fig. 1

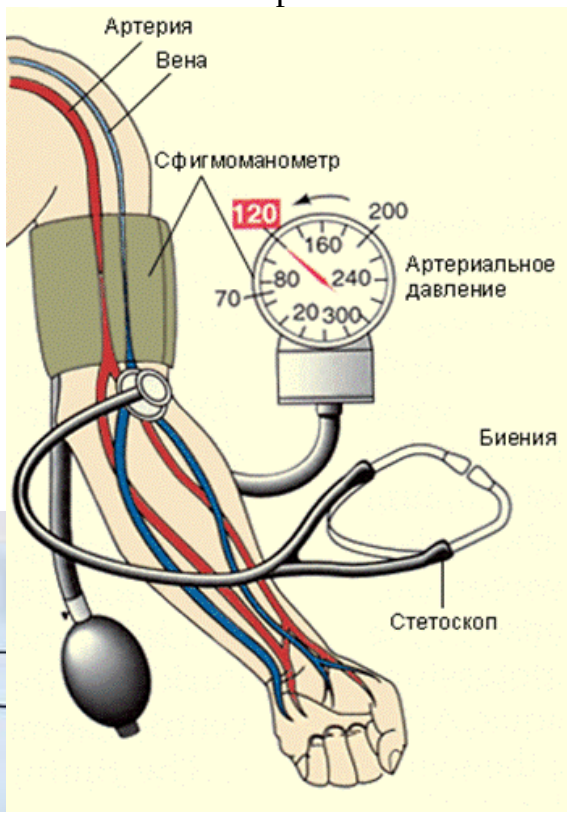
The components:

1 - a cuff; the phonendoscope :(2 - auditory tube; 3 membrane); 4 - air blower; 5 - gauge.

The pressure gauge has a movable holder and clamp. Air blower has 4-valve, through which the gradual reduction of pressure in the cuff.

b) Methods of measuring pressure

1. Do place the cuff.
2. Do place the stethoscope head to the point of pulsation.
3. Do plug your headphones into your ears.
4. Close the valve on the rubber bulb by turning the crown clockwise.
5. Clutching his right hand bulb, inflate the cuff and watch the pressure gauge. Once you no longer hear the pulse, continue to pump air into the cuff, increasing pressure to 160 mm.rt.st. (30-40 mm. Hg. more than the norm)
6. Slowly ajar air valve by turning the crown counterclockwise.
7. As soon as you hear a stethoscope Korotkoff, remember the manometer. This will be your systolic blood pressure.
8. Continue to let the air out of the cuff. When Korotkoff disappear, remember the manometer. This will be your diastolic blood pressure.

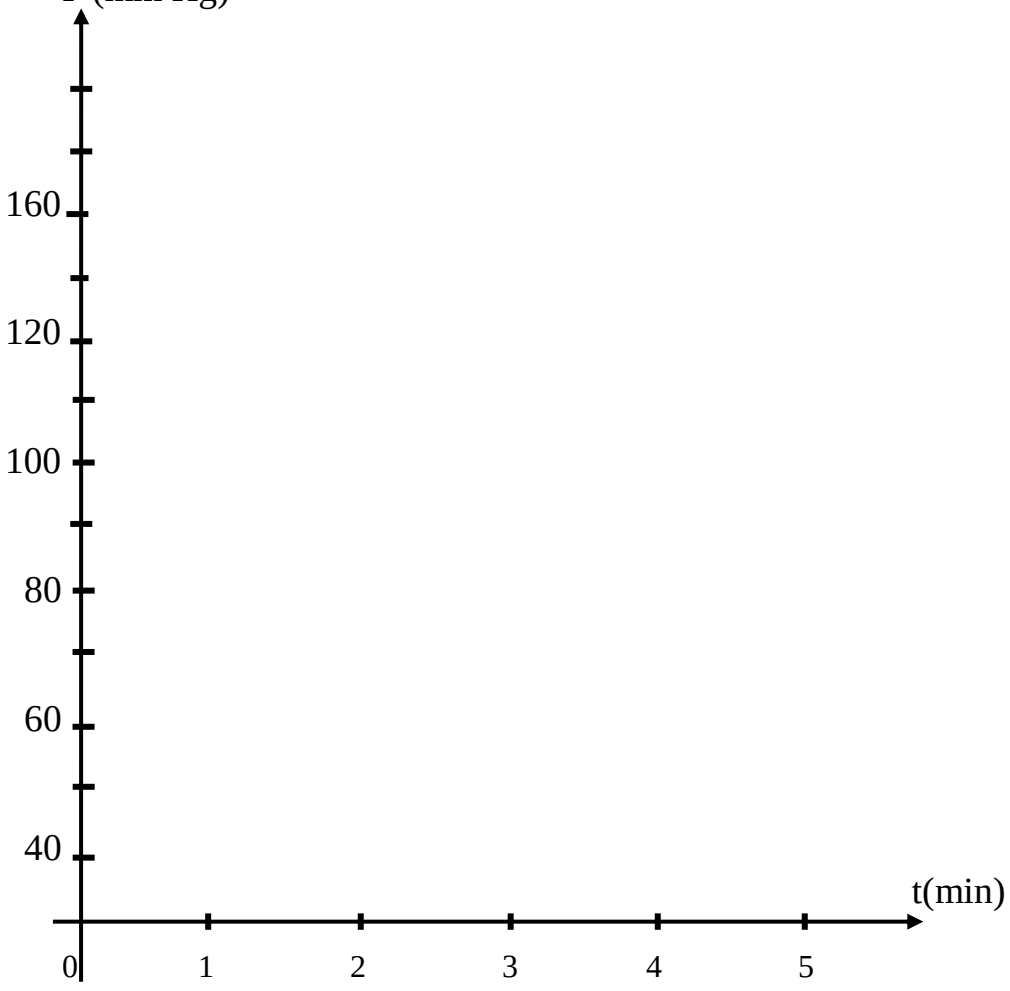


4. The practical part

1. Measure systolic and diastolic blood pressure at rest test and measure your heart rate.
2. Measure **systolic and diastolic pressure and pulse rate** test to exercise and physical activity after dosing (20 squats with a 1 second interval) through 1,2,3,4,5 minutes.
3. Data tabulated:

	Resting state (t =0)	After thrust				
		1 min	2 min	3 min	4 min	5 min
P_s						
P_d						
P_{pul}						
n						
Conclusion:						

1. Draw a graph of the system-wide blood pressure from time to time.



1. Draw conclusions about the dynamics of blood pressure and heart rate, on the nature of the circulatory apparatus adaptation to stress test.

Control questions:

1. Laminar and turbulent fluid flow
2. What the sense of Reynolds number ?
3. What caused the overall level of blood pressure?
4. What is the systolic (upper) blood pressure?
5. What is the diastolic (lower) pressure?

6. What is the blood pressure normal?
7. What is the high and low blood pressure?
8. What are the methods of measuring blood pressure?
9. Explain unit apparatus for measuring blood pressure.
10. Explain the mechanism of the appearance and disappearance of Korotkoff sounds when measuring pressure.
11. What are the adaptive capacity of the cardiovascular system?

Literature:

1. Paul Davidovits «Physics in Biology and Medicine», Third Edition, 2008, chapter: The Motion of Fluids, page 103-114.
1. Lecture on the topic: **Physical basis of hemodynamics.**

Tests on: «Study of a Apparatus for Measuring Blood Pressure»

1. **Normal blood flow is turbulent at:**
   1. arteries
   2. capillaries
   3. veins
   4. aorta
2. **In what vessels of cardiovascular system for a person in the norm-pressure of blood have a minimum - 6 mm Hg**
   1. in an aorta
   2. in артериолах
   3. in veins
   4. in capillaries
3. **Blood flow is laminar:**
   1. in atherosclerosis
   2. in large arteries
   3. in capillaries
   4. in the aorta
4. **Small circle of blood circulation starts at:**
   1. the left ventricle
   2. the right ventricle
   3. the left atrium
   4. the right atrium
5. **Tones of Korotkov disappear when the blood flow becomes:**
   1. turbulent
   2. laminar
   3. regular
   4. accelenated
6. **The nature of the flow of liquid through a pipe is determined:**
   1. Newton's equation
   2. number of Reynolds
   3. Poiseuille formula
   4. the law Stokes

7. **If nature of the flow of liquid is laminar, the Reynolds number:**
   1. more than a critical value
   2. less than a critical value
   3. equal to the critical value of the
   4. much more than a critical value
8. **Between the left atrium and the left ventricle is located valve:**
   1. aortic
   2. pulmonary
   3. tricuspid
   4. mitral
9. **The big circle of blood circulation begins in:**
   1. the left ventricle
   2. the right ventricle
   3. the left atrium
   4. the right atrium
10. **What is the reason of the heart noise appearance?**
   1. laminar current of blood in an aorta
   2. change of frequency of reductions of a cardiac muscle
   3. turbulent flow of blood about heart valves
   4. change of sound conductivity of fabrics

Laboratory work № 2

Registration Curve Threshold of Audibility

1. Purpose of work: Do construct the curve threshold of audibility and audiogram

2. Instruments and accessories: Audiometer-AA-02

Theoretical information

Audiometry is widely used in medicine the method of determining the downward (loss) hearing.

In diagnostics are also used other sound research methods: auscultation (listening to the sounds that occur inside the body), phonocardiography (record sounds, accompanying the work of the heart), percussion (analysis of sounds, arising when tapped special hammer of the body).

The understanding of the essence of these methods, as well as other questions relating to the operation of the sound perceiving and vocal apparatus correctly requires knowledge of the basic concepts of acoustics.

Sound is the mechanical vibrations of the particles in elastic media propagating in the form of longitudinal waves, the frequency of which lies within the perceived by a human ear on average from **16 to 20 000 Hz**.

Sounds are divided into tones, noise and sonic booms.

Tones separated into simple (harmonic) and complex. **Tone** is called sound, which represents the oscillation with constant amplitude and frequency. Simple (or harmonic tone can be obtained using a tuning fork or sound generator. The complex tones include, for example, the sounds of musical instruments, vowels sounds of human speech and other.

Noise is a combination of many different tones, frequency, form, intensity and duration of which randomly change. Noise may be short-term (knock, squeaking, crash etc) or long, as, for example, the prolong noise of various machines and mechanisms. Noise occur in natural conditions, accompanying various atmospheric phenomena (wind, turbulent streams of water, etc).

Sonic boom is a transient sound effect: clap, explosion, etc.

In the auditory sensation subjectively differ in **height, volume, and tone** (physical characteristics). These characteristics auditory sensations associated with objective (physical) characteristics of sound waves - **frequency** and **intensity of the wave**s and the **harmonic spectrum**.

The volume depends on the intensity and frequency of the sound. There is a minimum threshold intensity of sound in which sound is not perceived. This threshold intensity is different for different frequencies and is the lowest for the frequencies of 2500 - 3000 Hz.

Despite the subjectivity, the volume can be quantified by comparing the auditory sensations from two sources.

In a basis of creation of the volume level scale it is important to us psychophysical law **Weber-Fechner**.

If there are two sound of irritation with intensities **I** and $\mathbf{I_o}$, and $\mathbf{I_o}$ - hearing threshold, on the basis of the law of Weber-Fechner loudness with respect to it linked with intensity as follows: $\mathbf{L = k \cdot lg\,(I / I_0)}$,

where $\boldsymbol{\kappa}$ is the factor of proportionality depends on the frequency and intensity.

Conventionally to believe that at a frequency of 1 kHz a volume scale and intensity of the sound completely coincide, i.e. $\boldsymbol{\kappa=1}$ and $\mathbf{L = lg\,(I / I_0)}$.

To distinguish from the scale of sound intensity at scale volume decibels called **phon.**

Volume scale in the **phon** with the respective values of the sound of the tone frequency of 1 kHz shown in the table:

The approximate nature of the noise	**The volume phons**	**Sound intensity W/m^2**
Hearing threshold	0	10^{-12}
Heart sounds through a stethoscope	10	10^{-11}
Whisper	20	10^{-10}
Talk:		
quiet	40	10^{-8}
normal	50	10^{-7}
loud	60	10^{-6}
Noise on a busy street	70	10^{-5}
Scream	80	10^{-4}

The noise of the train station	90	10^{-3}
Siren	100	10^{-2}
The noise of an airplane engine	110	10^{-1}
Moreover in proximity	120	10^{0}
Pain threshold	130	10

When audiometry does on a special device (audiometer) to determine the threshold auditory sensations at different frequencies. The resulting curve is called an audiogram. Comparison of the audiogram sick person with normal curve threshold auditory sensations helps to diagnose the disease of the organs of hearing.

Principle of operation audiometer-AA-02

The appointment. Audiometer is designed to evaluate the functional state of the auditory analyzer person.

Functionality. Determination of the threshold of audibility tones at air and in bone sound conduction.

There is two two modes of operation when determining the thresholds: automatic and manual.

Preparation for work

- Connect phone, patient's button and the power cord to the appropriate jacks on the back panel of the audiometer.
- Connect it to the network.
- Turn on the audiometer (power switch is on the rear panel). The indicator audiometer the following will appear:

ТОН: 1000 Hz ПОДАЧА ПРАВОЕ ВОЗД. АВТОМАТ

- Instruct the subject: «Listen and press the **ANSWER** button when sound in phone. Remember to let go of the button each press».
- The subject should take place about the instrument, put on and fit to the band with phones (on the right ear must be «red» phone, on the left - «blue».)

Procedure of work

Attention! Before the beginning of the examination of each patient, press the **RESET** button, the results of a previous survey of memory audiometer will be deleted.

Automatic mode

Air sound conduction

During the examination, the signal tones are served in the following order: 1000, 1500, 2000, 3000, 4000, 6000, 8000, 750, 500, 250, 125 (Hz).

- The individual must press and release the **ANSWER** Audiometer automatically enters the mode of training.

Training is conducted with the purpose to teach the subject correctly to press the button of the **ANSWER** (right considered a pressing during the tone in the phone). Patient served served obviously audible sounds-tone first recorded frequency intensity 50 dB to 70 dB. Served the flow of sound is displayed on the indicator «asterisks»:

The subject should listen to sounds and press **ANSWER**. Each right clicking on аудиометре indicator is on the **ANSWER**.

If the examinee answers and gives three correct responses in a row, audiometer automatically go into work mode.

Operating mode

Survey served by tones of different frequencies. It should be borne in mind that in automated mode, the maximum level to listen to the sound of 95 dB. Value of frequency (Hz) and listening level (dB) is displayed on the indicator. In a study of the threshold values are automatically fixed in the memory of the audiometer. After determining the thresholds of the right ear of the survey process automatically repeated on the left ear with the same order of presentation of frequencies.

If necessary, you can interrupt the survey clicking on the **RESET** button. All results will be removed from memory audiometer, and the device returns to its original state.

• Upon completion of the program to identify thresholds air-conduction in the audiometer, the beeper will sound, and the audiometer automatically switches to playback mode. The indicator on the results of the survey appear, for example:

ЛЕВ. ВОЗД.	Hz	125	250	500	750	1000	1500
ВОСПР.	dB	45	35	30	--	10	15

- Pressing the **FREQUENCY△▽**, **LEFT** and **RIGHT**, review the values for threshold of audibility.

Practical part of the work

Task: To build a curve to the hearing threshold

1. The received results of research represented in a table and build the curves hearing threshold for the left and right ear.

Frequency (Hz)			125	250	500	750	1000	1500	2000	3000	4000	6000	8000
Thresholds (dB)	B	L											
		R											

2. Curves are obtained compared with the benchmark for a healthy ear and make conclusions.

Conclusion:

Control questions

1. Give definition of sound. Types of sound.
2. Give the definition of a pure tone, it's sources.
3. Give the definition of a complex tone, it's sources.
4. Physical and physiological characteristics of auditory sensation.
5. The Law Weber-Fechner.
6. Give the definition of the threshold of audibility, it's numerical value.
7. Give the definition of a threshold of pain, it's numerical value.
8. Units of measurement of volume levels: b, db, Phon.
9. Definition of audiometry.
10. Principle of operation of the audiometer.

11. What is called an audiogram and how to build it as to predetermined curve hearing threshold?

Literature

1. Paul Davidovits «Physics in Biology and Medicine», Third Edition, 2008, chapter**: Waves and Sound**, page 162-165, 168-175.
2. Lecture on the topic**: Sound.**

Tests on: « Registration Curve Threshold of Audibility »

1. **What value is characteristic of hearing?**
   1. volume
   2. intensity
   3. frequency
   4. hearing threshold
2. **Acoustic spectrum is a set .... with an indication of their relative intensity:**
   1. frequency
   2. amplitude
   3. sound
3. **The law Weber-Fechner establishes the correspondence between:**
   1. physical and physiological parameters of sound
   2. the volume and the amplitude of the sound
   3. the intensity of sound and the threshold of audibility
   4. the intensity of sound and the threshold of pain
4. **The basis of the apparatus for audiometry is:**
   1. sound level meter
   2. sound generator
   3. камerton
5. **The volume of the sound depends on...**
   1. the intensity of a sound wave
   2. properties of the medium, which is distributed sound
   3. acoustic spectrum
   4. the frequency of sound
6. **For the ear of the average person at a frequency of 1 kHz threshold of hearing correspond to the value of sound intensity:**
   1. $I = 10\ W/m^2$
   2. $I = 10^{-12}\ W/m^2$
   3. $I = 10^{12}\ W/m^2$
   4. $I = 100\ W/m^2$
7. **Audiometry-method definition:**
   1. the severity of hearing
   2. hearing threshold
   3. volume level
8. **The highest sensitivity of the ear of man lies in the range of:**
   1. 20-20000 Hz

2. 1000-5000 Hz
3. 5000-20000hz

9. Law Weber-Fechner described by the equation:
   1. $\Delta E = k \cdot Lg \frac{I}{I_0}$
   2. $\Delta E = 20 \cdot Lg \frac{I}{I_0}$
   3. $\Delta E = 10 \cdot Lg \frac{I}{I_0}$
10. **That is called the threshold of audibility ?**
    1. the minimum volume of the sound perceived by the ear
    2. the maximum volume of the sound perceived by the ear
    3. the minimum frequency of the sound perceived by the ear
    4. minimum intensity sound sensing ear

Laboratory work № 3

Definition Levels of Noise in Rooms of Different Types with the Help of a Device CENTER 320

The purpose of the work:

1. To acquaint students with exposure to noise,
2. To acquaint students with the principle of a work of a equipment for measuring of a loudness.

Instruments: the instrument for measuring the noise of the CENTER 320
Practical skills: master the methods of measurement of noise

A theoretical introduction:

In industry, agriculture and transport take place a large number of types of professional activity related to impact on the workers of a noise.

Sound - mechanic vibrations of the particles of the medium which propagating in the form of a longitudinal waves in the range of **16 to 20000Hz**. Sounds are divided into: tone, noise, sonic boom.

The tones can be simple or complex. Simple or pure tone is vibrations made with a constant frequency. Source of pure tone is a tuning fork. Vibrations with constant frequency are harmonic oscillations.

The main characteristics of harmonic oscillations are the **amplitude, frequency, period**. The deviation of oscillating body (or of the medium particles) from the equilibrium position is called **the amplitude of oscillations**. The period of time during which comes one complete oscillation is called the **period of**

oscillations (measured in seconds). The number of complete oscillations per unit of time is called **the frequency**. **Frequency** is measured in Hertz.
The sound is transmitted in the form of longitudinal waves.

The oscillations of the particles are forming the zones of condensation and rarefaction which alternately changing each other at each point of the environment. The distance between two points or thickening of exhaustion, having the same phase of the oscillation, is called the **wavelength**.

A sound wave is the carrier of mechanical energy. The energy transferred by mechanical wave through a unit area per unit of time is called **intensity** of the wave. Intensity is measured in **watts/m^2**.

For hygienic characteristics of the noise there are not physical values (pressure, energy), but relative, taking account of the subjective perception of the sound (volume). Increase of intensity of the sound causes an increase in its volume.

Minimum intensity perceived by the human ear is called the threshold of audibility and is equal to: **$I_0 = 10^{-12}$ W/m^2**.

Pain threshold: I=10 W/m^2.

The volume is measured in bell (0-13 B) or dB (**0 to 130 dB**).

1 Bell (B) - the volume of the generated clean tone of frequency 1000 Hz, with a change in the intensity of **10 times.** In practice make use a smaller units - decibels (dB).

Noise is a combination of many different colours, frequency, form, intensity and duration of which can randomly change. Noise may be short-term (knock, squeaking, clap, etc) or long, as, for example, the sustane noise of various working machines or mechanisms.

For example, the noise of the beating of his own heart is **10 dB**, a whisper - **20 dB**, the rustling of leaves - **30 dB**, loud speech - **70 dB**, car alarm - **90 dB**. In terms of production volume level reaches significant levels. Thus, noise in the boiler shops is **100-105 dB**, in the weaving workshops 105-110 dB manual riveting metal **110-115 dB**. Noise level exceeding **130 dB** causes pain feeling.

Adverse effect of the noise depends on:

1. intensity
2.duration
3.the spectral composition,
4. Initial functional state of organism, which is exposed to the noise influence.

Under the influence of noise in the body of workers to appear the multiple pathological changes, the severity of which depends on the ratio of the factors mentioned above.

Noise disease is a common disease of the body, characterized by predominant lesion of the Central nervous system and auditory analyzer.

Clinical manifestations that occur in people under the influence of noise, are divided into:

1. **Specific** (changes in the organ of hearing). The result of the influence of noise on hearing organ is the development of professional hearing loss and deafness.
2. **Nonspecific** (changes in other organs and systems). It's a violation of the

Central nervous system; cardiovascular system; respiratory system; the system senses of sight and vestibular apparatus; digestive system; glands of internal secretion and metabolism, blood system and other

In industrial conditions the source of sounds and noises are fluctuating solid, liquid and gaseous bodies, causing condensation and rarefaction of the air.

The frequency characteristic distinguish noise:

• low-frequency (16-350 Hz),
• medium frequency (350-800 Hz),
• high frequency (more than 800 Hz).

Auditory analyzer more sensitive to high tones, than to low therefore provides for a differentiated approach to the permissible levels of noise depending on its frequency response, and the time of exposure and the nature of work (table 1).

Table 1. **Maximum permissible levels of noise at working places (extract from the GOST 12.1.003-76)**

The noise spectrum	**Limit the frequency,Hz**	**volume Level, dB**
Low frequency	0-300	90-100
Mid-range	300-800	85-90
High frequency	Over 800	75-80

Noise limits for human

A person should live in a calm atmosphere, since constant noise harmful to health. Background noise should not exceed **55 dB** during the day and **45 dB** at night (normal conversation). However, the intensity of constantly surrounding noise much more. Only at the construction site or the street with intensive traffic noise often reaches **80-90 dB**. If a person is constantly works or lives in a noisy environment it may cause harm to the noise even small intensity. The maximum permissible **noise level** of **85 dB** is a limit beyond which there is a probability of damage to the receptors of hearing. Irreversible damage to the hearing may have visitors discos and rock concerts, because here the sound intensity can reach **130 dB**, causing even pain.

When sound levels over **160 decibel** - a possible rupture eardrums and lungs, more than **200** death (noise weapons).

Practical part of the work:

1. Measure the noise level during the lessons (silence).
2. Measure the noise level changes (noise).
3. To measure the level of noise in the street are noisy highway).
4. Compare the obtained values with maximum-permissible.
5. Data represented in a table:

№	**Noise level in dB**		
		Measured value	**Maximum allowable value**

1	during class		
2	during recess		
3	on the hall		
4			
5			

Registration of MIN/ MAX values

1. The device provides recording and playback, the minimum and maximum values during the observation. Before switching on mode, select the desired range of the measured levels, based on the expected values of a sound pressure.

2. Enable mode by pressing a button (MAX/ MIN). When this indicator is on MAX and on the main timeline displays the maximum value that can only be changed towards increase in the measurement process.

3. Successive pressing of the button MAX/ MIN switches modes of registration:

   - display of the minimum value of - turn indicator lights MIN, the value can only be changed towards a decrease in the measurement process;
   - displays the current values at the same time all indicators MAX/ MIN twinkle, and the maximum and minimum values are stored in memory;

4. To turn off mode, press and hold the MAX/ MIN for at least 2 seconds. Or else, press the selected button, select a different mode. The fixed maximum and minimum values will not be stored.

Organs indication LCD display

Organs indication	Purpose
MAX	Registration mode Max. values
MIN	Registration mode min
OVER	Measured level above the range of values

UNDER	Measured level below the range of values
FAST	Mode of measurements QUICKLY
SLOW	Mode of measurements SLOWLY
dBA	Unit of measurement the noise level when using weighted filter And type
dBC	Unit of measurement the noise level when using weighted filter-type
-Lo-	Measured level below 20 dB
AUTO	Mode Autoselect measuring range
REC	Recording mode is on in the memory of the Registrar
FULL	Indication overflow memory Registrar

Control questions:

1. Give definition sound.
2. Give a definition of pure and complex tones. Examples of sources of pure and complex tones.
3. Give the definition of the harmonic oscillation.
4. Give the definition of the length of the wave amplitude and frequency of the oscillation period. Units of measurement.
5. Give the definition of a unit volume: Bell.
6. Give a definition of the wave intensity, measurement units.
7. Give the definition of the threshold of audibility, the numerical value.
8. Give a definition of pain threshold, the numerical value.
9. Definition of noise.
10. What determines the adverse effect of the noise?
11. Determination of the noise of the disease.
12. What are the clinical manifestations occur in the organism under the influence of noise?
13. Frequency classification of noise.
14. What are the maximum permissible levels of noise at working places at different frequencies?

Literature

1. Paul Davidovits «Physics in Biology and Medicine», Third Edition, 2008, chapter: 12, Waves and Sound, page 162-165, 168-177.
2. Lecture on the topic: **Sound.**

Homework

1. **Prepare answers to questions on laboratory work: «Definition Levels of Noise in Rooms of Different Types with the Help of a Device CENTER 320».**
1. **Learn lecture on the topic: Sound.**

Tests on: « Definition Levels of Noise in Rooms of Different Types with the Help of a Device CENTER 320 »

1. **Normally permissible noise level is considered:**

1. 50-90 dB
2. 30-100 dB
3. 40-50 dB
4. 130 dB

2. **For the ear of the average person at a frequency of 1 kHz threshold of pain correspond to the value of sound intensity:**

1. $I = 10^{12}$ W/m2
2. $I = 10^{-12}$ W/m2
3. I = 10 W/m2
4. I = 100 W/m2

3. **Irreversible damage to the hearing can occur when sound intensity is:**

1. 30 dB
2. 85dB
3. 100dB
4. 130дб

4. **High frequency noise lie in the range:**

1. 16-350 Hz
2. 0-800 Hz
3. more than 800 Hz

5. **Sounds representing the combination of multiple tones, frequency, form, intensity and duration of which randomly change are called:**

1.infrasound
2. noise
3. acoustic spectrum

6. **The noise has:**

1. continuous spectrum
2. linear spectrum
3. constant frequency

7. **Punctured eardrums possible when the sound levels**:

1. more than 13дб
2. less than 130 dB
3. more than 85 dB
4. more than 160 dB

8. **Change of the volume of the tone frequency 1000 Hz, with a change in the intensity of sound at 10 times called:**

1. phon
2. bel
3. decibel

9. **Maximum permissible levels of high-frequency noise at the workplace:**

1. 90-100

2. 85-90
3. 75-80

10. **For the ear of the average person at a frequency of 1 kHz threshold of hearing correspond to the value of sound intensity:**

1. $I = 10\ W/m^2$
2. $I = 10^{-12}\ W/m^2$
3. $I = 10^{12}\ W/m^2$
4. $I = 100\ W/m^2$

Module №2

Laboratory work № 4

A Study of Medical Apparatus for Galvanization

1. Objective:

Study the device and the operating principle of the apparatus for galvanization.
2. To determine the threshold of pain.

2. **Instruments and accessories**

1. The apparatus for galvanization with a set of electrodes «Stream - 1».
2. Physiological solution, gauze pads.

1. A theoretical introduction

The galvanization is a method of a physical therapy, which uses the effects on the human body for therapeutic purposes of a constant current by low power (40-50 mA) and low voltage (40-50).

Electrical current for galvanization is supplied from the power source to the body of the person by means of wires and lead electrodes.
To improve the conduction of current through the skin we must apply the pads soaked in a saline solution.

Current is passed into the body through undamaged skin mainly on the excretory ducts sweat glands. Due to the small number of sweat glands and high ohmic resistance of the skin barrier in the galvanization the most of the voltage applied to the electrodes are at the skin and here is mostly absorbed an electrical energy. That is why when galvanization take place, first of all, there is a stimulation of skin receptors.

The action of a constant current in the body is determined by the current passing through the tissues and encourage in them physico-chemical shifts. Due to the complexity of the structure and heterogeneity of tissue microstructure a current passage and induced by it a moving of charged particles occur irregularly and not by the shortest path between the electrodes, as observed in homogeneous media. In the body of the talk a current covered the path of least ohmic resistance, mainly in

the intercellular spaces of the blood and lymphatic vessels, the membranes of nerves, muscles.

All effects that occur in the tissues of the body under the influence of apparatus for electroplating: electrolysis, polarization, ion asymmetry, electrodiffusive, electroosmosis.

Elektroliz

When a constant current passing through the body between electrodes arise an electric field. Under the influence of an electric field a molecule in the tissues break down into electrically charged ions. Positively charged ions (H^+, K^+, Na^+, Ca^+ etc.) moving on in direction to the cathode (negative electrode) and are called cations. Negatively charged ions (OH^-, Cl^-, CO_3^-, SO_3^- etc.) moving to the anode (positive electrode) and are called anions. Touched upon electrodes ions lose their electrical charge and become neutral atoms.

This process is called **electrolysis**. Interacting with water, these atoms form the products of electrolysis. Under the anode is formed acid (HCl), and under the cathode alkali (KOH, NaOH). The products of electrolysis are chemically active substances, which may cause chemical burns to the underlying tissues. To prevent scorch you must apply the pads soaked in a saline solution.

Polarization

Electric polarization is accumulation of the membranes of oppositely charged ions with the formation of the electromotive force, which has a direction opposite to the applied voltage.

Membrane create obstacles to the movement of currents, as they have capacitive properties(properties capacitor). Ions accumulate in the membranes and form an extension pole in the thickness of the tissue between which arise incremental currents, called «polarization currents». These currents increase resistance to the passage of the galvanic current in the tissues of the body. Polarization is occurring in tissues at the path of current flow. The polarisation damped within a few hours, that to some extent related to long-term aftereffect DC.

Ion asymmetry

DC when passing through the fabric cause the cations go to the cathode, and anions to the anode. Different speed of movement of ions related to the differences in their physico-chemical properties (charge, radius, hydration and others). So after galvanization does occurs here arise an ion asymmetry, affecting the livelihoods of cells, the rate of occurrence in them of biophysical, biochemical and electro-physiological processes. The most typical manifestation of ion asymmetry can be considered in the predominance at the cathode monovalent cations, and in the anode - ferrous anions. Such changes are accompanied by increased excitability of nerve endings at the cathode. In the anode happen opposite shifts.

Electrodiffusive

Electric current alters the permeability of fabrics and increases passive transport of large protein molecules and other substances.

Electroosmosis is the transfer of water by ions.

Under the action of electric field in the tissues occurs multidirectional movement

of molecules which are free or captured in the hydrate shell of ions (Na, K, Cl) water. Due to the fact that the number of molecules of water in a hydrate shells of cations more than anions, the water content under the cathode increases, under the anode is reduced.

Physiological and therapeutic effect.

The impact of galvanic current accompanied by the emergence of a variety of physiological reactions.

Local changes mainly relate to the skin. When galvanization develops redness, more pronounced under the cathode. It improves metabolism, provides the resorbing action, is the source reflex irritations. In the skin and underlying tissues is an intense formation of the biologically active substance (acetylcholine, histamine, heparin and other), mainly on the cathode. Under the influence of galvanization amplify the oxidative processes in the skin, increasing the number of active skin glands.

Redistribution of ions, the accumulation of electrolysis products, the formation of biologically active compounds and other physico-chemical shifts lead to irritation of receptors embedded in the skin.

When galvanization marked ischemia and cardiac activity, reduction of high pressure, improve blood circulation and stimulates the trophic processes in organs, stimulates lymph circulation, strengthening the secretory and motor functions of stomach and intestines, improving metabolic functions of the liver. In General, on the condition of internal organs galvanization has a positive effect.

Medical electrophoresis is a method of treatment for which the introduction medicinal substances through the skin or mucous membranes with using direct current.

Ions drugs are introduced only in the epidermis, forming a skin depot. The drug is washed with the blood and lymph flow and spread through the body. The mechanism of therapeutic action of medicinal electrophoresis consists of physiological influence of galvanic current and pharmacological effects of drugs. When conducting electrophoresis it is need to take into consideration the polarity of the electrodes.

With apply of the positive electrode (anode) in the tissues of the body entered metal ions (K, Na, Ca), novocaine, vitamin B12, etc.

With apply of the negative electrode (cathode) in the tissues of the body enter acid radicals and negatively charged particles of complex compounds (bromine, iodine, heparin, antibiotics, etc.).

Indications for use of medicinal electrophoresis: neuralgia, neuritis (for pain relief), neurosis (insomnia), inflammatory infiltrates (dispersible inflammatory process).

Contraindications: malignant tumors, acute inflammatory diseases, intolerance of the current.

The electrophoresis to other ways of introducing drugs into the body there are a number of advantages:

- the combined effect of DC and medicinal substances;

- the opportunity to support local action by surface location of the pathological center;
- a small dose of medicinal substances;
- long action medicinal substances owing to the delayed receipt of his skin depot into the blood flow.
- the ability to selectively enter one or other of ion solution.

The apparatus for galvanization is an AC adapter, equipped with a filter to the smoothing of pulsations, of alternating current.

The apparatus for galvanization is an AC adapter, equipped with a filter to the smoothing of pulsations, of alternating current.

Appearance

1. signal lamp
2 - switch of voltage
3 - handle of a potentiometer
4 - circuit breaker
5 - output terminals
6 - switch bypass
7 - milliammeter

The block diagram of the apparatus for galvanization (Fig.1) includes:
- step-down transformer;
- rectifier with smoothing filter;
- therapeutic contour (potentiometer, milliammeter, terminals for connection of the patient).

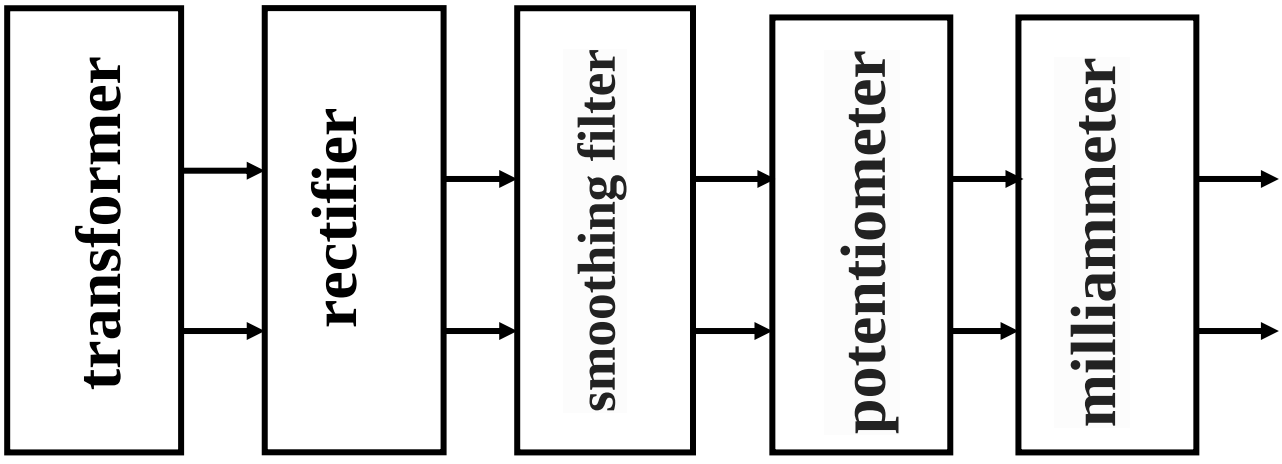


Fig.1

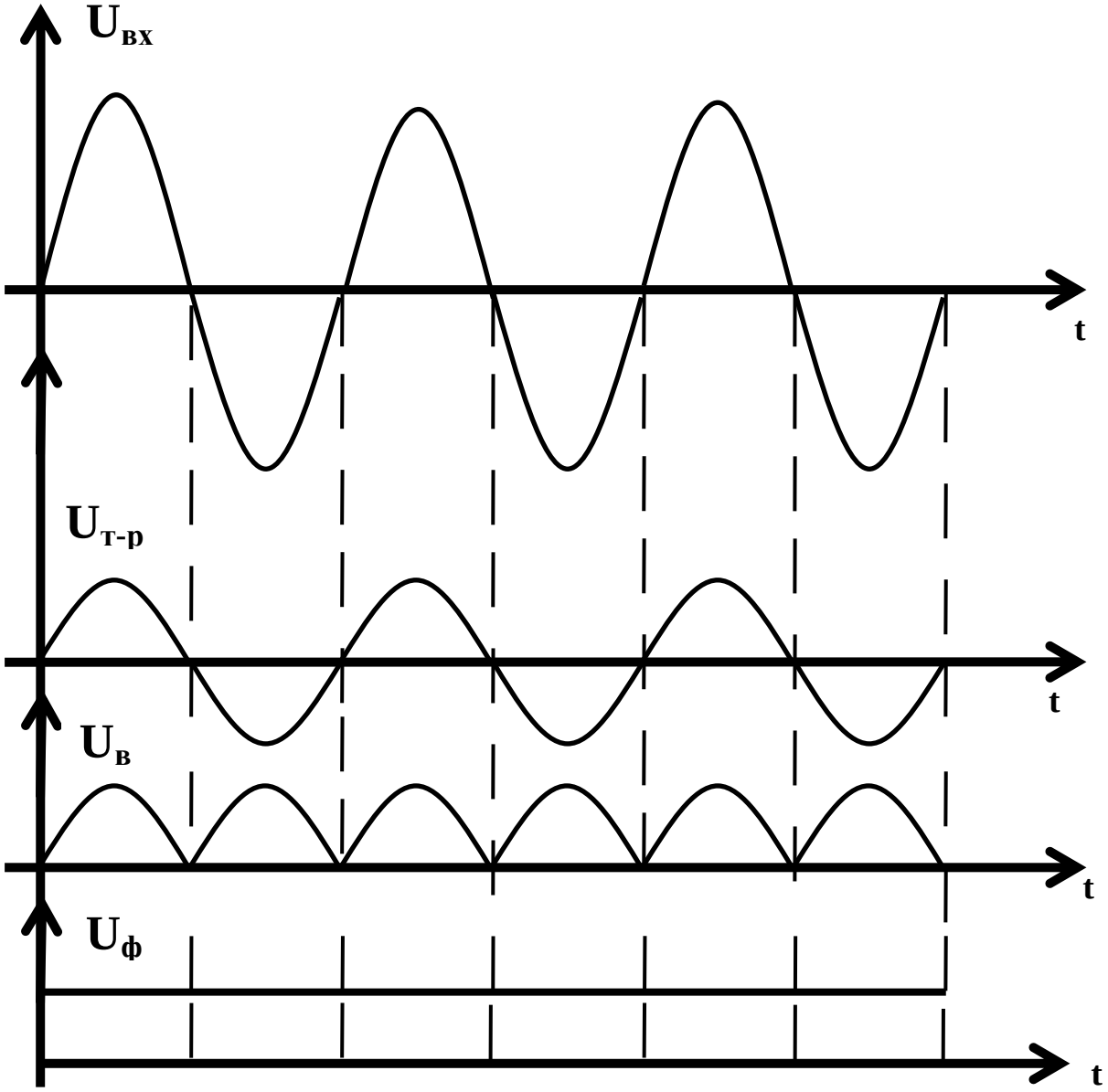


fig.2

1.The first block is a step-down transformer, reducing the voltage at the input($\mathbf{U_{вх}}$) from 220 to 40-60 In output of transformer **($\mathbf{U_{t\text{-}R}}$)**.

2. Second block-rectifier is going on semiconductor diodes. Instead sinusoidal AC appears pulsating current in one direction (DC).

4. Smoothing filter consists of inductor and capacitor and the need to reduce the ripple current.

5. The voltage is removed the terminal patient with potentiometer and measured by milliammeter. The potentiometer is needed to regulate the intensity of current in the circuit of the patient.

The form of voltage shown in figure 2:

The Uвх-mains voltage,

$\mathbf{U_{t\,R}}$ - output voltage transformer,

$\mathbf{U_B}$ - output voltage of the rectifier
$\mathbf{U_f}$ - the voltage at the output of the filter,
$\mathbf{U_{вых}}$ - voltage supplied to the patient.

The research part of the work

Job 1

Acquaintance with the device, the principle of action and electrical circuit apparatus.

1. Before you turn the device into the network, the switch to position «off», the potentiometer is in the extreme left position, the switch bypass milliammeter - in position 5 mA.
2. Put the power switch in the " on " position. To give the machine to warm up for 2 minutes.
3. Turning the potentiometer to the right, you need to follow the movement of the arrow milliammeter. Smooth slider potentiometer arrow milliammeter should move clockwise smoothly and without jumps.
4. If it has, the phone is in good order and ready for use.
5. When returning the slider potentiometer in the leftmost position, you can begin treatment.

Job 2

Determination of the threshold of pain.

1. To find the area of the electrodes.
2. Connecting to the output terminals lead electrodes covered with gauze soaked in physiological solution, to strengthen the electrodes at opposite sides of the hand.
3. At slow rotation of the handle of a potentiometer to determine the lowest current which causes a slight tingling. To repeat the experience of three times, to calculate the average current.
4. To determine the threshold of pain by the formula: $J = \frac{I_n}{S}$

where j - is the threshold of pain;

I_n - power current (mA);

S - size of the electrode (cm^2).

5. The experiment data is recorded in the table:

№	The length of the electrode (sm)	Width electrode (sm)	The area of the electrode S(sm^2)	Current strength I(mA)	The current density J(A/sm^2)	Average value current density J(A/sm^2)
1.						
2.						
3.						

Conclusion:

Test Questions

1. Give the definition of the method galvanization.
2. To explain the effects that occur in the tissues of the body under the influence of DC(electrolysis, polarization, ion asymmetry, electrodiffusive, electroosmosis).
3. Physiological and therapeutic effect of galvanising.
4. To explain the block diagram of the apparatus for galvanization.
5. Electrophoresis, definitions, rationale and benefits over other methods of introduction of medicinal substance.
6. Explain the effect of the medicinal electrophoresis.
7. What drug ions can be entered by electrophoresis in the organism of the patient?
8. Describe the indications for therapeutic application of electroplating and medical electrophoresis.
9. The algorithm of definition of the threshold of pain.

Literature

1. Paul Davidovits «Physics in Biology and Medicine», Third Edition, 2008, chapter:, page.

2.Lecture on the topic: Physiotherapy.

Tests on: « A Study of Medical Apparatus for Galvanization »

1. **Galvanization is a method, which is used with the medical purpose impact on patient:**
   1. electromagnetic field
   2. the electrical component of the electromagnetic field
   3. DC in continuous mode low voltage (40-80V), low power (up to 50mA)
   4. DC to pulse mode
2. **Electrophoresis is a method combining the effects on the body for therapeutic purposes:**
   1. electromagnetic fields and electromagnetic waves
   2. continuous current and input from its use of medicinal substances
   3. constant current in pulse mode and input from its use of medicinal substances

3. Position in the order of the blocks of apparatus for galvanization:
1. smoothing filter
2. the transformer
3. milliammeter
4. rectifier
5. Electrodes

4. All effects that occur in the tissues of the body under the influence of apparatus for electroplating:
1. the thermal effect
2. resonant absorption of the energy of the water molecules
3. excitation fabrics
4. electrolysis, polarization, ion asymmetry, electrodiffusive, electroosmosis

5. When galvanization positively charged ions (H+, K+, Na+, Ca+ etc.) towards the cathode and interacting with water produced products of electrolysis:
1. acid (HCl)
2. alkali (KOH, NaOH)

6. The accumulation of membranes oppositely-charged ions with the formation of the electromotive force, which has a direction opposite to the applied voltage is called:
1. electric polarization
2. ion asymmetry
3. electrodiffusive
4. Electroosmosis

7. Pain threshold is determined by the formula:

1. $j = \frac{I_n}{S}$

2. $\frac{d^2q}{dt^2} = a$

3. $i_n = \frac{a}{t} + b$

8. When the galvanization of the body with current spreads:
1. the path of least ohmic resistance,
2. on the shortest path between electrodes

9. Electrolysis is the collapse of the molecules in the tissue on electrically charged ions under the influence:
1. ultraviolet radiation
2. x-ray radiation
3. magnetic field
4. a constant electric field

10. **Катионы-это..... , которые движутся по направлению к катоду отрицательному электроду):**
1. положительно заряженные ионы (**H^+, K^+, Na^+, Ca^{2+}** и т.д.)
2. отрицательно заряженные ионы (**OH^-, Cl^-, CO_3^-, SO_3^-** и т.д.)

Laboratory work № 5
Study Device for Local Darsonvalization "DE-212 CARAT"

Objective: To familiarize with work devices for local darsonvalization "DE-212 CARAT."

Instruments and accessories:

1. apparatus "DE-212 CARAT"
2. set of gas-filled electrodes

Theoretical introduction

In air and other gases in natural conditions there is always a small amount of free electrons and ions formed as a result of ionizing effect of environmental factors: ultraviolet part of solar radiation, cosmic radiation, radiation from radioactive substances in the earth's crust, etc.

Ionization - is electron detachment from the outer orbit.

Ionization of the gas, taking place under the influence of external forces, called the **primary ionization**.

If the gas is maintained in which the primary ionization and two electrodes arranged to apply a DC voltage thereto, the electrodes occurs between the motion of electrons and ions - an electric current.

When moving electrons and ions collide with atoms and molecules of gas (elastic and inelastic). Electron in an elastic collision with an atom or molecule can cause ionization of an atom or molecule of gas. This phenomenon is called **secondary ionization** and leads to a rapid increase in the number of charge carriers in the gas, respectively, increases and amperage.

The electric current in the gas is accompanied by a gas, sound phenomena (hissing, cracking), education in ozone and nitrogen oxides, etc. The combination of these phenomena is called an **electric discharge in a gas**.

Depending on the intensity of the ion flow electric discharge in gases at atmospheric pressure is divided into quiet and spark. When quiet discharge ion flux has low intensity. This raises the vibrational motion of air particles, there is a characteristic sound - hiss.

At sufficiently high voltage between the electrodes occurs **spark**. He is much more intense ion flux. Spark accompanied by a bright glow and strong bang.

Darsonvalization - physiotherapy is the method based on the use of medium frequency alternating current (110-400 KHz), high voltage (30 kV) and low power (0.02 mA).

For local use darsonvalization bell-shaped pulses of alternating current. Pulse repetition frequency of 50 imp • s^{-1} (Fig. 1). The pulse duration is 100 ms. The current in the discharge does not exceed 0.02 mA and voltage of 50 V.

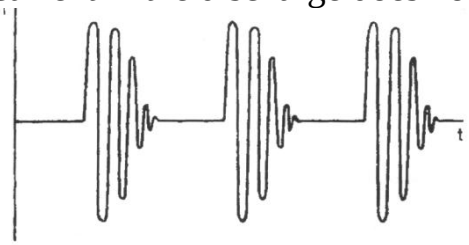


Fig. 1 (abscissa - time-t, the vertical axis - current).

The air inside the glass electrodes of different shapes (Fig. 2) to rarefied 6,7-13,5 Pa.

Fig. 2 Condenser vacuum electrodes for local darsonvalization:

1 - pectinate;
2 - rectal;
3 - earplug;
4 - mushroom;
5 - heart;
6 - coagulation

Biophysics effects of medium frequency alternating current on the human body

Electrical current of low strength does not cause significant heat generation in the tissue. Alternating current character does not have time to cause significant changes in ionic membranes and tissue, respectively, when exposed darsonvalization arises muscle contractility.

Local darsonvalization based on summing the high voltage to the electrode through a vacuum skin.

Therapeutic effect in the local darsonvalization

Therapeutic effect in the local darsonvalization provides electrical discharge that occurs between the skin of the patient and suction electrode.
Response of the body to the impact of the current at the local mid darsonvalization local character. Intermittent vasospasm replaced extension of the lumen, improves blood and lymph circulation, reduced venous stasis phenomena, resolve inflammatory lesions, improving tissue blood flow with increased oxygen content in the skin. In general, changes in blood circulation accompanied by improvement of trophic tissue simultaneously stimulated tissue metabolism in the body.

Decreasing function of the sweat and sebaceous glands. After an hour after the procedure revealed hyperemia, which disappears in a day.

Spark discharge leads to lesions in the skin mikronekroz is accompanied by stimulation of phagocytosis and the release of biologically active substances. Entering the blood protein decomposition products stimulate metabolism. In addition, the spark and electrode formed in the space of about ozone and nitrogen oxides are able to exert a bactericidal effect.

Widely used in cosmetic darsonvalization local practice, in particular to improve the functional condition of the skin, improving its elasticity, prevent the development of wrinkles, baldness by reducing the sweat and sebaceous glands, hair growth and hair loss.

Darsonvalization improves muscle performance and stimulates callus formation, improves the functional status of the various organs and tissues.

Two techniques are generally accepted local darsonvalization: **contact and remote.**

When **the contact** electrode **method** smoothly usual vacuum dried on the face, which leads to a quiet discharge.

In remote procedure electrode usual bumps and then separated from the surface of the hearth processed to form an air layer 0.5-2 cm or usual continuously over the skin massaging gently with the creation of a very narrow air gap that creates a tingling sensation in the patient.

Electric current flows through the ionized gas or vacuum electrode and the glass wall and goes to the air layer, where there is low or spark, which through the skin of the patient goes into the ground. Discharge accompanied by a pink glow. To amplify it is necessary to increase the air layer between the skin and the electrode - then spark becomes more intense.

Therapeutic effect is manifested in darsonvalization analgesic, antipruritic, vasomotor action, as well as the stimulation of healing of tissue injury, increase tissue metabolism with improved tissue nutrition.

Indications

Apply with cardiac neurosis, peripheral nerve neuralgia, varicose veins, chilblains effects, long-term healing wounds, neuritis of the auditory nerve, itching for diabetes or eczema, etc. The most commonly used in cosmetic procedures - cleaning face with acne, facial massage with aging skin.

Apparatus for local darsonvalization "DE-212 CARAT"

Included - 4 nozzles that allow most efficiently handle any areas of the body:

- **Nozzle-comb** - hair and scalp;
- **Nozzle-fungus** - skin, neck, chest and any other exposed areas of the body;
- **Nozzle-stick** - point acne and cavity;
- **Nozzle-slingshot** (it - T-Shaped) - spine, neck, and large areas of the body (for example, in the treatment of cellulite).

The main part of the device:

The device is a generator of electrical oscillations of medium frequency, high voltage and low intensity, providing a quiet appearance and spark discharges in a gas-filled electrode. The device provides the ability to control the voltage applied to the electrode.

The main part of the apparatus for darsonvalization:

- Transformer;
- High voltage generator;
- A set of gas-filled electrodes.

Working with the device "DE-212 CARAT"

1. Install the electrode holder, not putting considerable effort to the cylinder electrode. Little effort Clockwise screw the chuck electrode cap. Make sure that the electrode is sufficiently firmly attached and set the regulator output voltage amplitude to the leftmost position.
2. Connect the device to the AC mains.
3. Regulator to set the necessary amplitude intensity spark on individual feeling, ie should feel a slight tingling sensation, does not cause discomfort. Electrode continuously and smoothly move on painful areas, not taking away from the body surface.
4. After the procedure, the regulator output voltage amplitude set to the extreme left and only then remove the electrode from the body and remove the device from the network.
5. Remove the electrode from the holder by unscrewing the screw chuck.

Test Questions

1. Define ionization.
2 . List kinds of natural factors under the influence of which the formation of ions in the air and other gases in vivo.
3 . Give an idea of the primary and secondary ionization.
4 . What is the electric current in the gas?
5 . What is called an electric discharge in a gas?
6. Types of discharges in the gas.
7. Give a characterization of the spark discharge.
8. Define local darsonvalization.
9. Physiological and therapeutic action darsonvalization.
10 . Techniques local darsonvalization.
11. Indications and contraindications local darsonvalization.
12. Design and principle of operation of the apparatus " DE 212 CARAT ."

Literature

1. Paul Davidovits «Physics in Biology and Medicine», Third Edition, 2008, chapter:, page.

2.Lecture on the topic: Physiotherapy.

Tests on: Study Device for Local Darsonvalization "DE-212 CARAT"

1. **Method of influence with the medical purpose pulse alternating sinusoidal current of high frequency (110 or 440kHz), high voltage (20 kV) and low power (0,02mA) is called:**
   1. electrostimulation
   2. darsonvalization
   3. electrophoresis
   4. galvanization
2. **Local darsonvalization based on summing up of high voltage to the skin through:**
   1. lead electrodes
   2. point electrode
   3. round electrodes
   4. vacuum glass electrode
3. **The electric current in gaza is a movement between the electrodes:**
   1. ions
   2. electron
   3. positive charges
   4. electrons and ions
4. **To specify the types of natural factors, which may cause the formation of ions in air and other gases in natural conditions:**
   1. the ultraviolet part of solar radiation, cosmic radiation, radioactive radiation
   2. ultrasonic radiation
   3. laser radiation
   4. infrasonic radiation
5. **The air inside the glass electrodes at the local darsonvalization**
   1. is the atmospheric pressure
   2. has a pressure above atmospheric
   3. attenuated to 6.7-13,5 PA
   4. has a pressure below atmospheric
6. **Ionization is:**
   1. the gap nucleus of the atom
   2. attach electrons to the atom
   3. separation of the electron from the outer orbit of the atom
   4. the detachment of a proton from a nucleus of the atom
7. **Electric discharge in gas is the set of phenomena, including:**
   1. the glow of gas, sound effects (hissing, crackling), education in the air ozone and nitrogen oxides, the movement of ions.
   2. the movement of electrons
   3. ultrasonic phenomena
   4. separation of the electron from the outer orbit of the atom
8. **Spark discharge accompanied by:**
   1. a bright glow and strong crack
   2. ultrasonic radiation

3. laser radiation
4. infrasound radiation

9. **Spark discharge when darsonvalization provides:**
1. thermal action
2. ion shifts
3. bactericidal effect
4. muscular contractility

10. **The main part of the device for darsonvalization:**
1. generator sustained oscillations
2. transformer, high voltage generator, a set of gas-filled electrodes
3. transformer, a rectifier and smoothing filter, milliammeter
4. power source, valve, oscillating contour, coil feedback, therapeutic contour

Laboratory work № 6

The Study of Apparatus for Electric Stimulation

1. Objective: 1. Explore the physical basis of the device for electrostimulation.
2. Cause movement of the fingers muscle stimulation forearm.

2. Devices: Electronic massager to stimulate nerve endings OMRON.

3. Theoretical introduction

Pulse currents are used for electric diagnostics and electrostimulation.

Electrodiagnostics is the application of electrical current to determine the state and capabilities of certain organs and systems based on their reaction with different exposure settings.

Before performing electrical stimulation, first performed electrodiagnostics. When Electrodiagnostics selected pulse parameters (frequency, duration, amplitude) at which the restored motor function of the affected organ).

Electrical stimulation - a therapeutic effect of pulsed direct current of low frequency (0,5-160 Hz), low amperage (do15mA) and a pulse duration of 1 - 1000 mc.

Electrical stimulation - therapeutic use of pulsed current to restore the activity of organs and tissues that have lost normal function. In physiotherapy apply electrical stimulation to affect the damaged nerves and muscles and internal organs containing smooth muscle wall of its elements (bronchi, gastrointestinal tract, bladder).

When choosing an electrical pulse current form, the pulse repetition rate and regulate their amplitude. Duration used for electrical pulses is 1-1000 ms. For the muscles of the face and brush current is 3.5 mA, and for the muscles of the shoulder, hip and thigh - 10-15 mA. The frequency of skeletal muscle-150-180 Hz, 400-600 Hz nerve fibers.

Electric continuous direct current has a galvanizing (polarizing) effect on excitable tissues: nervous, muscular, glandular.

In AC - irritant effect. Galvanizing effect virtually none.

To save the current irritant and eliminate galvanizing effect on the fabric of his intermittent use **direct current**, which is called the **pulse current**. Most irritant effect is observed when the circuit and open circuit at the negative electrode (cathode), minimal - a positive electrode (anode).

Law DuBois-Reymond

Irritation is called when the current depends on the rate of change of current:

$$\frac{dI}{dt} = \frac{d^2q}{dt^2} = a$$

Irritability current is due to the acceleration in the movement of ions tissue electrolytes.

Consider a single pulse constant current.

Irritability single current pulse depends on:

- form
- duration
- amplitude
- pulse repetition frequency

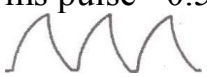
To carry out the classical electrical currents used the following form:

1. Direct current manual interruption duration:

2. Pulse current rectangular (Leduc current) 0.1-100ms duration, frequency 0,5-160 · imp s-1:

3. Pulse current triangular shape (tetaniziruyuschy current) with pulse duration of 1-1.5 ms, with a frequency of 100 imp·c^{-1}.

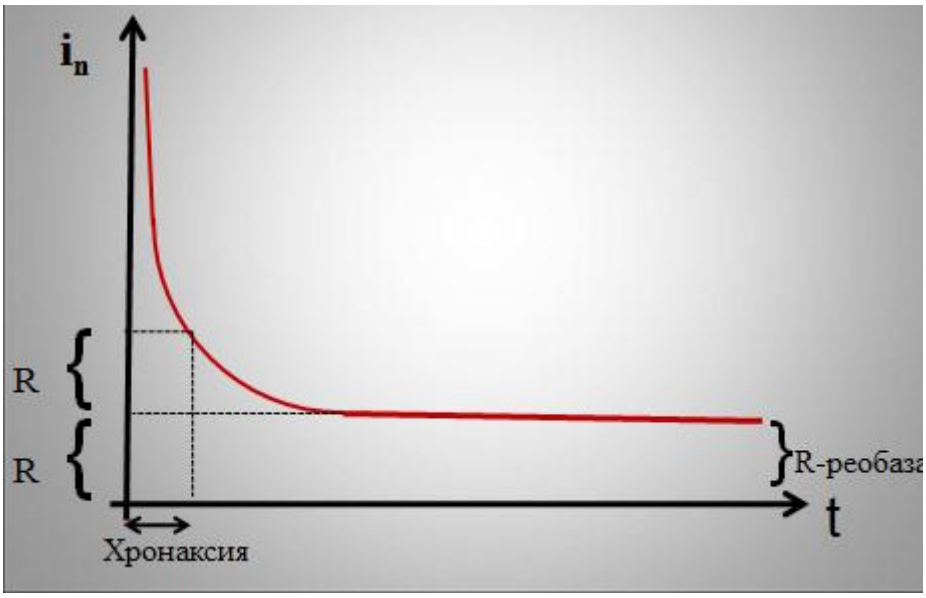
4. Pulse current exponential form (Lapicque currents), duration and frequency of 1,6-60 ms pulse · 0.5-120 imp·c^{-1}.



Irritability rectangular pulses is largely dependent on their duration, causes the greatest displacement of the ion for the duration of the pulse. This dependence is described by **Weiss-Lapicque:**

where i_n-threshold current. $$i_n = \frac{a}{t} + b$$

Schedule dependence of the threshold current of the pulse duration



Conclusion:

1. Short pulses are non-irritating ($i_n \to \infty$)
2. The pulse duration is irritating, does not depend on the pulse duration.
   tn-threshold current is called rheobase.
3. **Rheobasis** is the threshold current at which the irritant effect does not depend on the pulse duration.
4. **Chronaxy** is a pulse having a double rheobase.

The impact mechanism constant current pulsed

Constant current in pulsed mode is:

- tissue redistribution of ions in electrolyte cell membranes,
- change conventional biochemistry tissues
- change in the intensity of metabolic processes,
- increased excitability at the cathode and dropping it at the anode
- increase blood flow to the muscles excited,
- synthesis of nucleic acids (RNA)
- stimulation of muscle activity.

Irritation electric pulse current in most of the tissues causes the same reaction as the natural excitement. This phenomenon is used in medicine for diagnosis and treatment of various organs and systems of the body, mainly the nervous and muscle tissue.

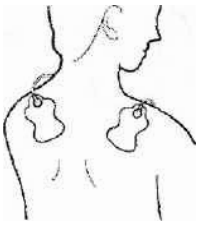
In the lab, we study the electronic massager to stimulate nerve endings OMRON. This electronic nerve stimulator is designed for use as a massager to relieve muscle pain, numbness and fatigue. Massaging effect is achieved by stimulation of the nerve fibers of the electronic means of the electrode plates attached to the skin.

Capabilities of the device

1. **Three modes of massage:** Shoulder sector, waist and feet.
2. **Ability to select the intensity** of five levels of intensity.
3. **Electrode plates of large size.** The size of the electrode plates is increased to a large area has been involved, and thus improved the efficiency of the massage.

Operation of the device

1. Connect the power cord to the electrode plates.
2. Insert the appliance plug into the socket of the electronic unit.
3. Attach the plate to these areas in accordance with these illustrations.



Recommendations for massage

Duration: 10-15 minutes per zone
Frequency: 1-2 times a day
Intensity: at the level of comfortable feeling

Control questions:

1. To give a definition of electrical stimulation.
2. To define electric diagnostics. The purpose electric diagnostics.
3. What is the impact of direct current from the AC on the body.
4. What is the irritant effect of a single pulse current?
5. The law Dubois-Reymond, its meaning.
6. List the main types of pulse currents used for classical electrostimulation.
7. The graph of the dependence of the threshold current intensity from pulse duration, its meaning.
8. Equation Weiss-branches wrapping, its meaning.
9. To define rheobase and chronaxy, their purpose.

10. The mechanism of action of a pulse of a current on the body by electrical stimulation.
11. Operation of the device.

Literature

1. Paul Davidovits «Physics in Biology and Medicine», Third Edition, 2008, chapter:, page.
2.Lecture on the topic: **Physiotherapy.**

Tests on: « The Study of Apparatus for Electric Stimulation »

1. **Electrical stimulation is a therapeutic effect:**
   1. constant current large forces (more than 15 mA) in the pulse mode, pulse duration (1-10 ms) and repetition rate (5-16 Hz)
   2. alternating current of low power (doma)
   3. constant current of low power (do 15mA) in the pulse mode, pulse duration (1-1000 mc) and repetition rate (0.5 to 160 Hz)
   4. alternating current large forces (more than 15 mA)
2. **According to the law Dubois-Reymond irritant effect DC current in pulse mode occurs when:**
   1. a constant velocity of ions
   2. the accelerated movement of ions
   3. variable speed of the movement of ions
   4. speed of movement of ions is equal to zero
3. **The law Dubois-Reymond gives the dependence of the threshold current from:**
   1. pulse shape
   2. pulse duration
   3. pulse amplitude
   4. frequency pulse
4. **Chronaxy is the pulse duration:**
   1. having a triple rheobase
   2. having long
   3. they have low duration
   4. having a dual rheobase
5. **Irritant effect of a single pulse depends on:**
   1. forms, duration, amplitude
   2. sign of the charge
   3. voltage
   4. the magnitude of the electric field
6. **Electrical stimulation is used for influence on:**
   1**.** damaged nerves and muscles
   2. the brain
   3. bone system

7. **Rheobasis is the threshold current at which irritant effect:**
   1. not depend on the duration of the pulse
   2. depends on the frequency of the pulse
   3. depends from the pulse amplitude
   4. depends on pulse duration
8. **The electric diagnostics is the definition of the condition and functionality of certain organs and systems, depending on their response for various parameters exposure:**
   1. direct continuous current
   2. alternating current
   3. direct current in pulse mode
   4. electromagnetic field
9. **What physical quantity is chronaxy?**
   1. current strength
   2. voltage
   3. time
   4. frequency
10. **Current strength when stimulation is for the muscles of the shoulder, hip and thigh:**
   1**.** 3-5 mA
   2. 10-15 mA
   3. 1-15 0 mA
   4. 3-50 mA

Laboratory work № 7

Study Device UHF-Treatment

1. Objective:

1. Familiarize with the mechanism and the principle of operation of the apparatus UHF- treatment
2. Investigate the thermal effect of the alternating electric field of the apparatus UHF- treatment

2. Instruments and accessories

1. Apparatus UHF 66.
2. 2 bulbs with the solution.
3. Indicator light (neon).
4. Thermometers

3. Theoretical introduction

UHF- treatment is a method of physical therapy. It is used effect on the human body with curative intent electric component of the electromagnetic field of ultrahigh frequency (40.68 MHz)

Electromagnetics field presents the complex of two variables, mutually inducing each other electric and magnetic fields. There are two components- electric and magnetic in electromagnetics field.

Electric field (EF) is formed by resting charged bodies. The most important characteristic of the power EP is - an intensity E. The unit of measurement of the intensity is in the $V \cdot m^{-1}$

Magnetic field (MF) is formed by moving charges, magnetized body and an alternating electric field. The most important characteristic is the MP is magnetic induction (**B**), which is measured in tesla (Tl).

The tissue of the human body in electrical properties can be divided into the conductors of electric current and dielectrics.

Conductors (electrolytes) it is the body have good electrically conduction. They are parts of body fluids (blood, lymph, bile, cerebrospinal fluid, urine) and also muscle tissue.

Dielectrics is a body without conducting an electric current. Such as tissue: bone, fat, nerve, coarse-fibered connective tissue and tooth enamel.

UHF field effects on human tissue observed at two effects:

1. thermal
2. no thermal (oscillatory or physic-chemical effect)

The mechanism of action of the electric field UHF on solutions of electrolytes and dielectrics in thermal dosage

1. **Heating** electrolytes in the UHF is due to the movement of ions, i.e conduction current.Thus the energy of the current passes in internal.The amount of caloric (**q**), which stood out in the unit of thetime in the unit of the volume of the electrolyte depends on the electric field:

$$\mathbf{q_1 = E^2/\rho,}$$ where

E-meaning of intension electric field

ρ-the resistance of the electrolyte

In a dielectric under the influence of high-frequency electric field go on continuous reorientation of dipole moments. Polar molecules perform rotational motion about a mean position. Strengthening of the molecules is accompanied by an increase in inventories of their kinetic energy, which corresponds to a rise in temperature, (energy of electric field is transformed into caloric energy).

2. Oscillations of dipole phase lag of the oscillations of the electric field. The amount of caloric generated per unit volume of the dielectric per unit time is expressed by the formula:

$$\mathbf{q_2 = \omega E^2 \varepsilon \varepsilon_0 tg\delta,}$$ where

ω – thecircular frequency of oscillation

ε –the relative permittivity of the dielectric;

ε_0-dielectric constant of vacuum

E- meaning intensivity of electric field

δ –angle of dielectric loss

The structure of body includes tissues having properties of both electrolytes and dielectrics, therefore under the influence of UHF field generates caloric in the tissue: $\mathbf{q = q_1 + q_2}$

When the frequency of vibration of the electric field make strength of 40.68 MHz, dielectric heating is more intense than the electrolytes, i.e. the fat and water-containing structures are heated unevenly. For example, when the knee-joint is exposed to the subcutaneous fat to be heated more intensely than the synovial fluid.

Thermogenesisis largely dependent on the power of the field and the energy absorption tissues.

The mechanism of action of the electric field in the UHF by not thermal dosage

Application of an electric field in the UHF by not thermal dosage has expressed oscillatory action. Oscillatory motion of charged particles lead to physical and chemical changes in the cellular and molecular structure of tissues.

Isolate thermal and oscillatory action is almost impossible, so responses of the organism associated with the aggregated effect of an electric field UHF.

In some methods, you can create an advantage of thermal or oscillator action.

Medical indications

Most fully was investigated the effects of electric field UHF inflammation (joints, neuralgia, asthma, encephalitis and other diseases in non-acute phase).

Influence of electric field UHF causes dilation of capillaries, arterioles, accelerate blood circulation, lowering blood pressure.

In the middle of inflammation increases the amount of calcium ions. Electric field of UHF reduces bacterial activity, at the same time slows down the absorption of toxic products from the focus of inflammation.

Electric field of UHF has antispastic effect on smooth muscles of the stomach, intestine, gall bladder, bronchia.

Physical basis of the apparatus UHF- treatment

Apparatus UHF- treatment consists of two main blocks:

1. Continuous oscillations generator
2. Therapeutic circuit

Continuous oscillations generator consists of:

1. oscillatory circuit
2.origin of the sustenance
3. valve
4.feedback

Continuous oscillations generator is base of apparatus UHF- treatment

Block diagram of apparatus UHF-treatment

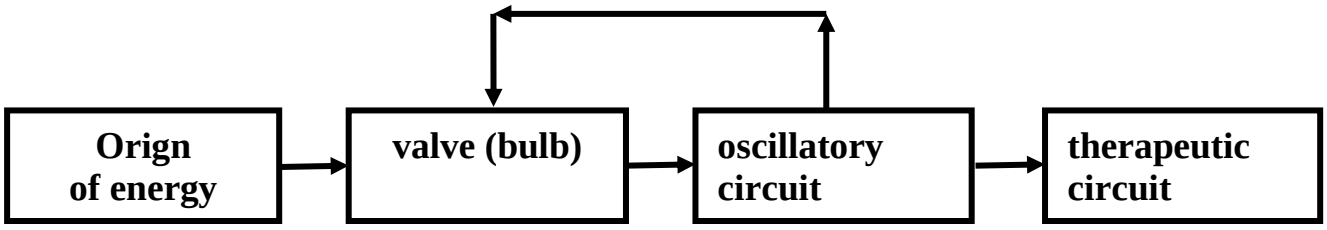


Рис 1

1. **Oscillatory circuit-** consists of spool of inductance **L** and condenser of capacitance **C.**

In oscillatory circuit happens twice during the period the transformation energy of electric field in the condenser of the magnetic field energy of the coil and contrary (**Oscillatory circuit** is source of electromagnetic oscillations).

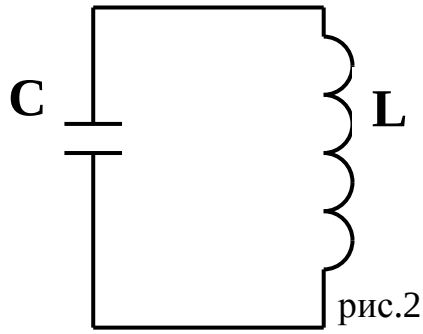


рис.2

2. **Power of source** (battery) – is necessary to oscillations are not damped. Energy from the source must come to an Oscillatory circuit rather than continuously in time with the natural oscillations.

3. **Valve** is necessary for the regulation of energy input from the battery to the circuit.

4**. Feedback** is necessary to control operation of valve.

In addition high-frequency oscillation generator works as a relatively high voltage feeding the lamp. **Electrodes** are included in a separate oscillating circuit- **therapeutic (TC)** that the patient could not have been exposed this high voltage. Oscillatory circuit is inductively coupled with the contour of generator. Due to the fact that the circuit has therapeutic properties (e.g. the different parts the patient's body) having different electrical parameters, this circuit must adapt to resonance every procedure. For this condenser it has a variable capacitance .

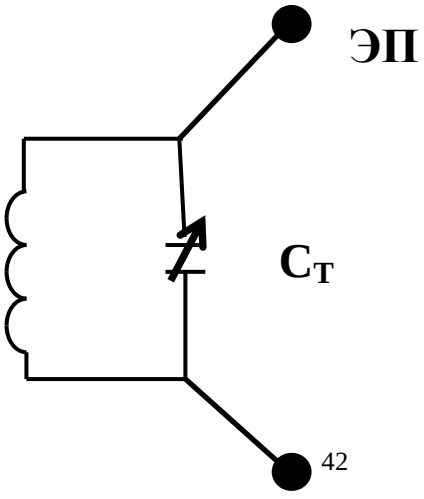


Рис3.

Control elements are located on the front panel and have corresponding label.
Switch **"Voltage"** is used to regulation voltage. Control voltage is performed by pressing "Control". To change the power supplied by the generator switch is **"Power"**, which has four positions: 0, 20, 40, 70 watts. Capacity variable capacitor circuit therapeutic changes handle **"Settings".**

The appearance of the instrument

Working with the UHF-66

1. Connect.
2. Put control knobs apparatus to the starting position: switch **"Power"** to **0**, the switch **"Voltage"** to **"Off."**
3. Press **"Control"** and increasing the voltage with the switch **"Voltage"**, set the arrow apparatus within the red sector.
4. Allow the unit to warm up 1.5 - 2 min. and only then set the knob **"Power"** in position 70.
5. Hold the setting indication between the electrodes and by turning the **"Settings",** achieve maximum glow of neon bulb.
6. Turn off the apparatus, turn the knob switch **"Power"** to 0, and the selector knob **"Voltage"** - in the "Off" position. Disconnect the Power from the wall outlet.

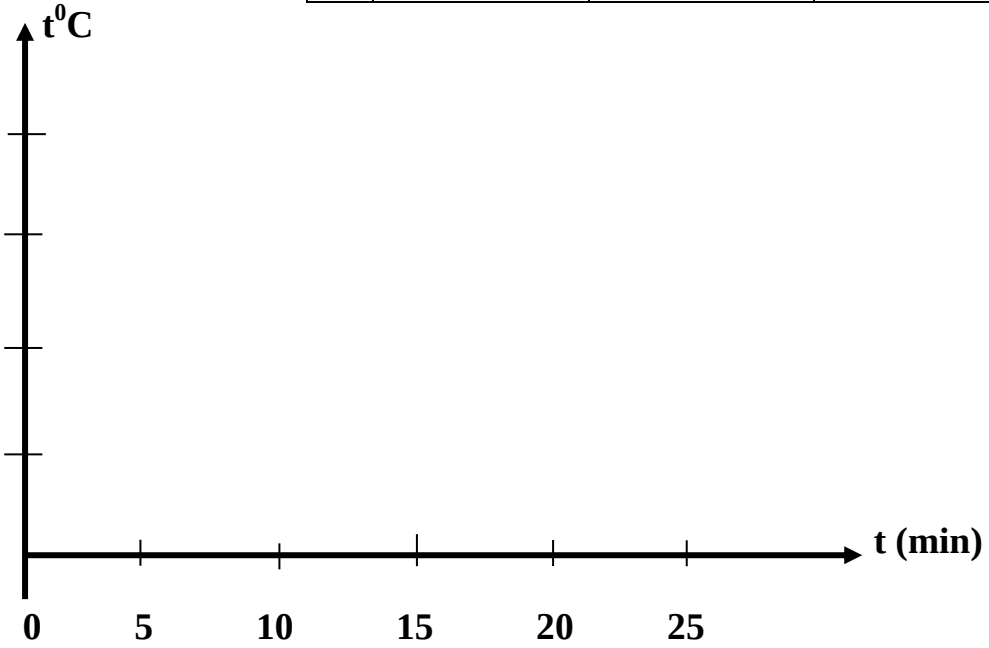
Safety instructions

For security purposes, patient and service personnel when the network apparatus is prohibited: to avoid burns by high frequency, you must never touch electrodes and wires by metal objects.

The research part of the work

1. Put the between the electrodes apparatus UHF two vessels, one with a salt solution (electrolyte), the other - with vaseline oil (dielectric).
2. Pull down into vessels thermometers measure start temperature of the solutions.
3. Measure the temperature every 5 minutes (for 25 minutes), the data tabulated.
4. Construct graphics of temperature versus time for the electrolytes and dielectrics.

№	Time (min)	Temperature °C	
		vaseline oil	Solution NaCl
1	0		
2	5		
3	10		
4	15		
5	20		
6	25		



Conclusion:

Test Questions

1. Define UHF-therapy.
2. Give the definition of the electromagnetic field.
3. What is a characteristic of the electromagnetic field, unit of measure.
4. What is a characteristic of the magnetic field, unit of measurement.
5. Define conductors of electric current and dielectrics.
6. Any tissue of the body can be attributed to the conductors of electric current?
7. Any tissue of the body can be attributed to dielectricum?
8. Explain the mechanism of action of the electric field in the UHF solutions electrolytes in heat dosage, formula, its meaning.
9. Explain the mechanism of action of the electric field in the UHF

dielectrics in heat dosage, formula, its meaning.
10. Explain the mechanism of action of the electric field in the UHF solutions of electrolytes and dielectrics in no heat dosage.
11. Which blocks up the UHF unit? Explain the purpose of the blocks.
12. Explain the flow chart generator sustained oscillations. Explain the purpose of the blocks.
13. What are the basic rules on safety?
14. Explain the practical part of the work.

Literature

1. Paul Davidovits «Physics in Biology and Medicine», Third Edition, 2008, chapter:, page.
2.Lecture on the topic: **Physiotherapy.**

Tests on: « Study Apparatus UHF-Treatment»

1. **UHF-therapy is a method of physical therapy which use the effect of radiation on the human body for therapeutic purposes:**
   1. the magnetic component of the electromagnetic field of ultrahigh frequency
   2. a constant electric field
   3. electric component of the electromagnetic field, ultra-high frequency (**40.68 MHz**)
   4. a constant magnetic field
2. **Conductors (electrolytes) - it is a material :**.
   1.not conducting electrical current
   2. poorly electrically conductive
   3. good electrically conductive
3. **Dielectrics -it is material :**
   1. not conducting electrical current
   2. poorly electrically conductive
   3. good electrically conductive
4. **The electromagnetic field is a composite of two:**
   1.invariable, mutually excitation by each other electric and magnetic fields
   2. variables, mutually excitation by each other electric and magnetic fields
   3. constant electric and magnetic fields
5. **The conductors of electric current are:**
   1. bone, fat, nervous
   2. coarse-fibered connective tissue of the tooth enamel
   3. blood, lymph, bile, cerebrospinal fluid, urine, muscle tissue
6. **Bad-conductive fabric:**
   1. bone, fat, nervous, coarse-fibered connecting fabric, tooth enamel
   2. blood, lymph, bile cerebrospinal fluid, urine, muscle tissue
7. **The amount of heat released in a unit of volume of a dielectric to a unit of time is expressed by the formula**:
   1. $q_1 = E^2/\rho$
   2. $q_2 = \omega E^2 \varepsilon\varepsilon_0 \operatorname{tg}\delta$

3. $q = q_1 + q_2$

8. **Generator sustained oscillations consists of:**
   1. the oscillatory circuit, power source, valve, feedback
   2. therapeutic contour
   3. inductor and capacitor
9. **Oscillating circuit is:**
   1. source of the electric field
   2. power source
   3. the source of the magnetic field
   4. the source of electromagnetic oscillations
10. **In dielectric under the action of high-frequency electric field occurs:**
   1**.** uniform motion of ions
   2. oscillatory motion of ions
   3. re-orientation of the dipole molecules
   4. uniform motion of the dipole molecules

Laboratory work № 8
An Electrocardiogram and Construction of a Vector of EMF Heart

1. The object of the work:

1. To acquire the skill of working with digital ECG system.
2. Record electrocardiogram (ECG).
3. Construction a vector of EMF heart.
4. Do learn how to calculate the time intervals on the ECG.
5. Do learn how to calculate voltage peaks ECG.

2. Instruments and accessories:

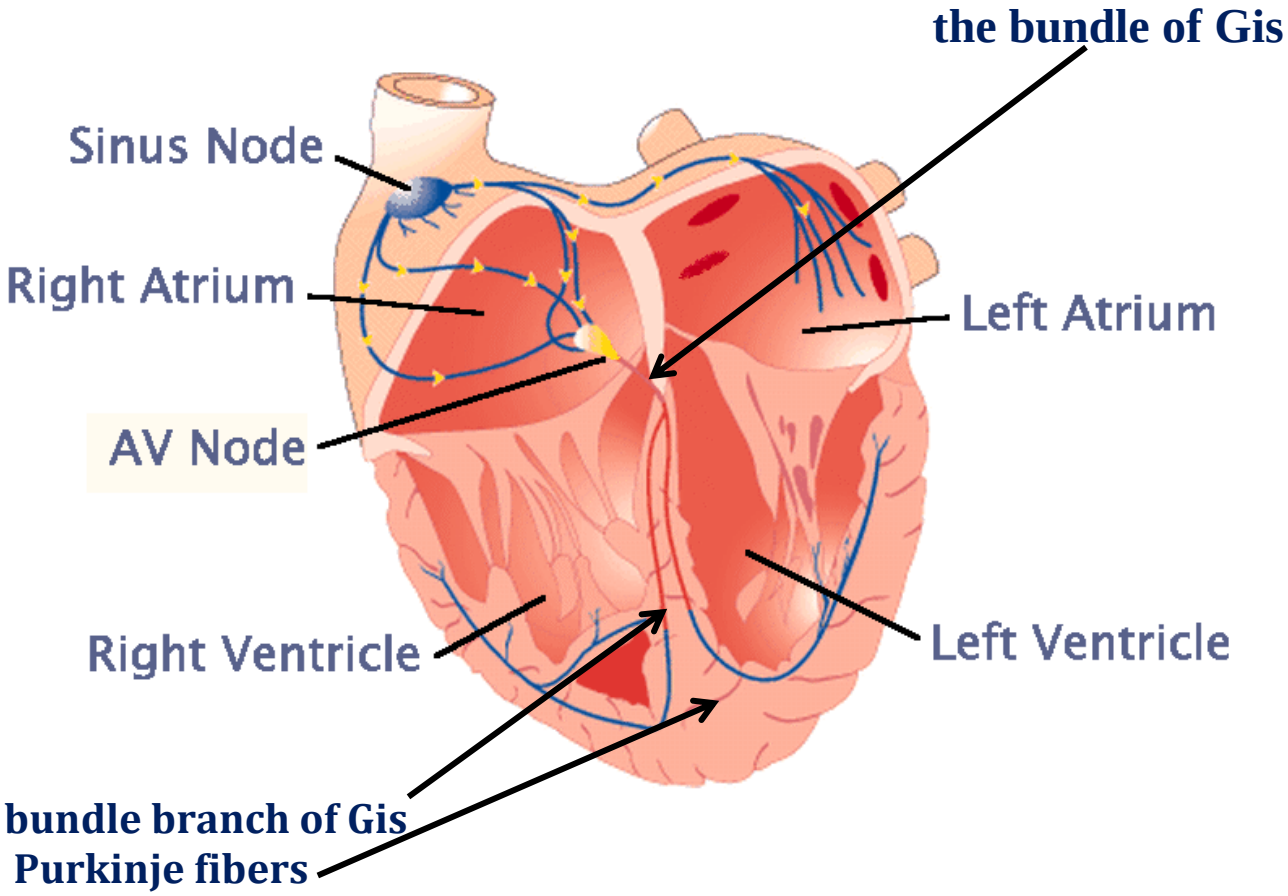
1. Electrocardiograph
2. Set of electrodes
3. Saline

3. A theoretical introduction

Electrocardiography called physical method of registration of the electrical activity of the heart with the help of the amplifier biopotentials-electrocardiograph.

Theoretical substantiation of the method is reduced the idea of heart from the Dutch scientist Einthoven, as about the electric dipole placed in low-conductivity environment.

The numerous studies have found that an electric generator of the heart is localized in sinus node (Fig.1).This site has property of automaticity, because generates electrical potentials periodically.



In turn, sinus node is part of the cardiac conduction system.

The vascular system of the heart includes:

1. sinus node;
2. atrioventricular node;
3. the bundle of Gis;
4. bundle branch of Gis;
5. Purkinje fibers;

Heart like an electric dipole creates an electrical field and electrical power lines will be coming out on the surface of the body. On the surface of the body can be distinguished line of equal potential (Fig.2). Horny plot heart is charged negatively the relation to unstimulated, then the upper right part of the body will be charged negatively, and the lower left portion positively.

If the voltmeter connected to two areas of the body surface, which differ with regard to its potential, it registers the potential difference.

Changing in time the potential difference between two points on the surface of the body is called an **electrocardiogram** (Fig.3).

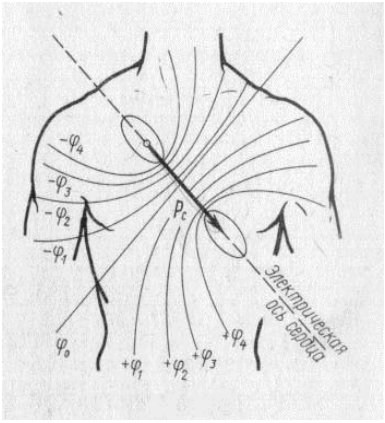


рис.2

Electrocardiogram of healthy heart

The origin of certain elements of the electrocardiogram

1. **Prong P** - Electric activity (depolarization) atrial. Normal positive, registers the algebraic sum of the excitations of the right (ascending part) and left (descending part) atrial.
2. **Segment PQ**-Δφ-const. Excitement is distributed by conducting system of the heart.
3. **Prong Q** - reflects the depolarization of the interventricular septum goes down.
4. **Prong R** - corresponds to almost full coverage of the excitation of both ventricles, the highest spike ECG - directed upwards.
5. **Prong S** - final element of ventricular complex, when both ventricles covered excitation.

QRS complex initial part of ventricular complex, adequate phase full ventricular depolarization.

6. **Segment ST**, Δφ-const. The ventricles are in an excited state and the excitement is stored a certain period of time.
7. **Prong T** - ends ventricular complex, when terminated depolarization, that is, comes the repolarization of both ventricles.
8. **Segment TP**-Δφ-const-diastole.

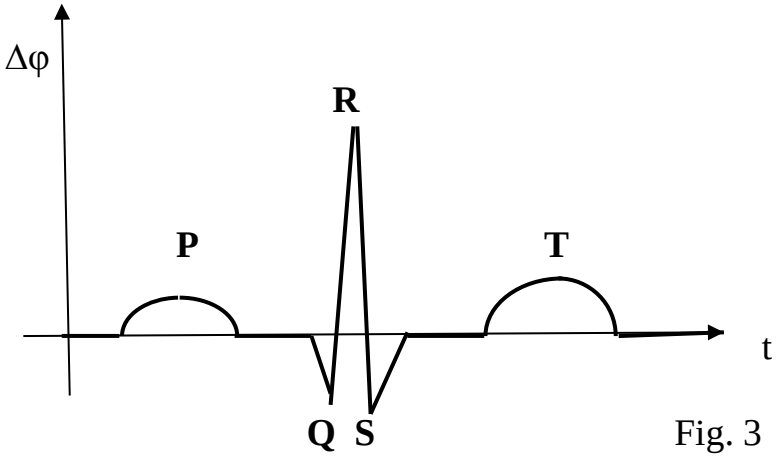


Fig. 3

To make a measurement and ECG recording standard, Einthoven suggested to consider that heart is a dipole which placed in the center of an equilateral triangle, and the tissues of the body have the same electrical conductivity in all directions. For the unification of such

measurements, he proposed to measure the potential difference between the vertices of the triangle (limbs).
The corresponding pairs of points were named derivations (Fig.4):
1-st derivation: the left hand (**LH**) - right hand (**RH**),
2-nd derivation: the right hand (**RH**) - the left foot (**LF**),
3-rd derivation: left foot (**LF**) - the left hand (**LH**).

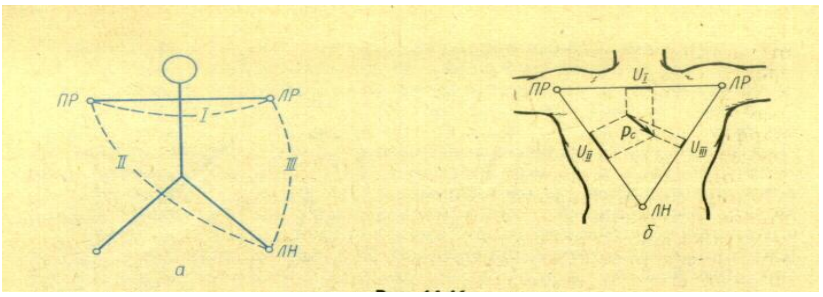


Fig. 4

Electrical axis of heart is called the axis of the electric dipole. Vector EMF heart can be built using triangle Einthoven as shown in figure 5.

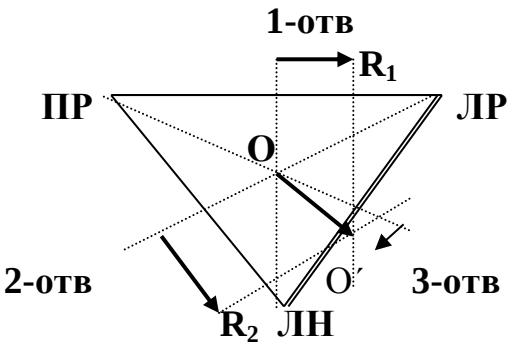


Fig. 5

To form a vector EMF heart on ECG must to construct an equilateral triangle and to the middles of it sides restore the perpendiculars to mutual crossing at the point **0.**

Then in the three leads do measure the amplitude of the relevant teeth, for example, teeth, **R**. Postpone the obtained values on the sides of the triangle, as shown in figure 5.

Restore the perpendiculars from the ends of the vectors of leads to mutual crossing at the point **O**. Cut **O O'** can be regarded now as a vector of EMF heart, and he lies on electrical axis of heart.

Block diagram of an electrocardiograph

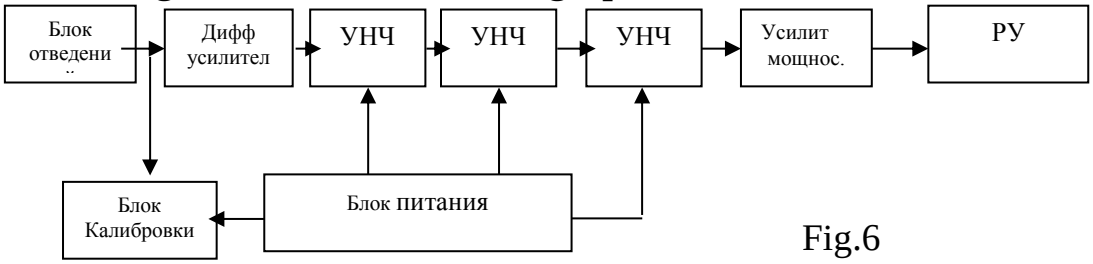


Fig.6

With the help of special electrode a potential difference with standard leads through the block leads go to a differential amplifier, where there is a clearing of the useful signal from noise. Purified from interference a useful signal from the output of the differential amplifier is served on 3 cascaded amplifier voltage of low frequency (**ULF**). When passing through the **ULF** an amplitude of the useful signal is significantly increased to compared with the amplitude of the input signal.

After increasing the potential difference of a useful signal at the amplifier (power supply). It is formed signal strength according to the law, P=U*I. Reinforced thus, the useful signal is recorded on the monitor screen.

In the study electrocardiograph in as the recording device is used the pen to write on termocondactive (coated with wax) tape. A heated pen does touch the paper tape coated with wax. Paper tape is pulled from the pen by the tape mechanism at a constant speed. Our unit-**25 mm/s or 50 mm/sec**. Therefore, when changing the potentials of heart output ULF on the paper raises them to scan time.

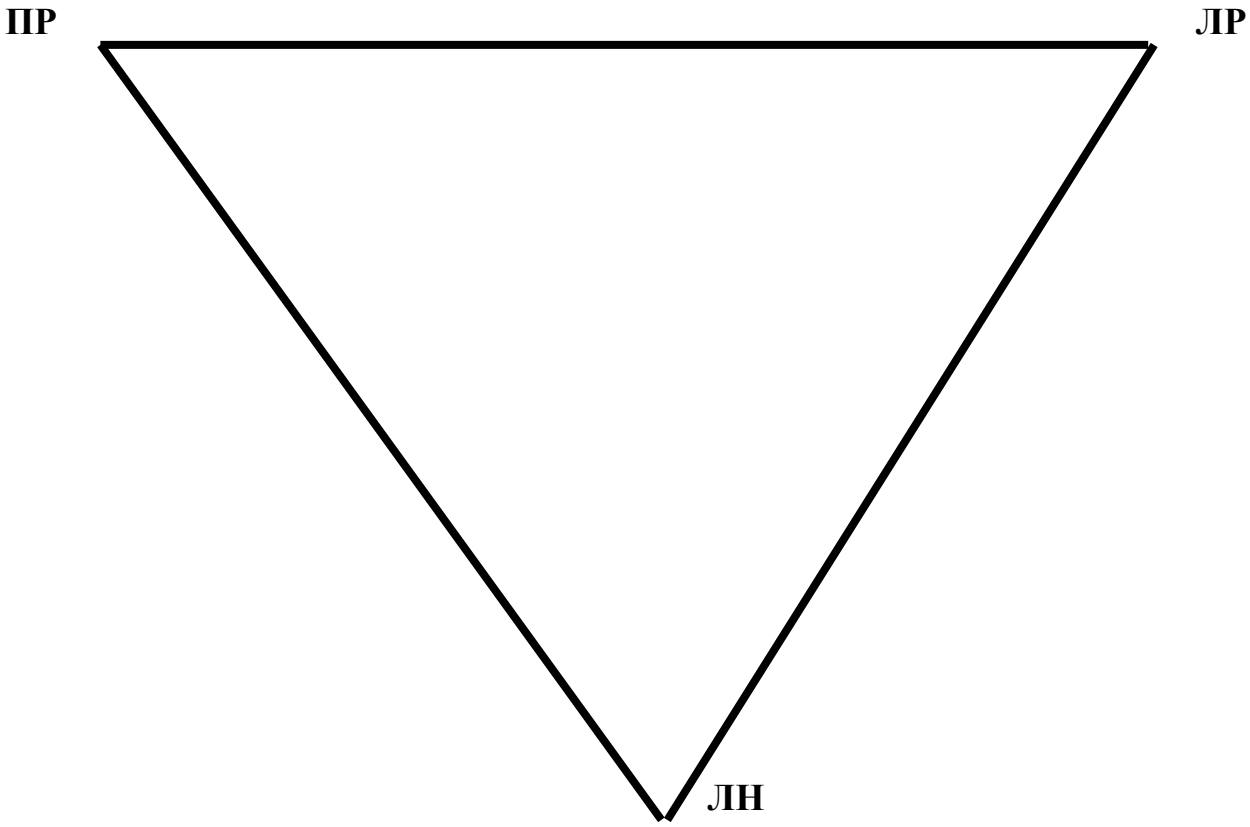
Any ECG contains calibration block. It is a source of stable voltage of **1 mV**, switched Calibration «**1mV**».

When you click calibration, voltage, **1 mV** to the input of the **ULF** instead of biocapacity, amplified and recorded in the form of a rectangular pulse on a paper tape. Such an impulse subsequently used for the calibration of the **ECG**.

Research part of the work

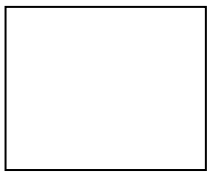
1. The construction of the vector EMF heart

1. To build a vector EMF heart draw an equilateral triangle (the party of about **7 sm**) Einthoven top downward.
2. The parties and the vertices of the triangle mark in accordance with the theory of Einthoven numbers corresponding leads and letters adjacent to the extremities.
3. Spend the height and find the center of the triangle point **O** (the intersection point of heights).
4. Glue prong **R** cardiogram in each of the leads on the sides of the triangle as shown in Fig.6 i.e. on the side **RH-LH** of the from the middle of the right hand amplitude of the **R** wave in the **first** abduction, on the side of a **RH-LF** - down amplitude of the **R** wave in the **second** abduction and, finally, on the side of the **LH-LF** down **- R**-wave amplitude in the **III** abduction.
5. Restore the perpendiculars from the ends of the teeth R pending on the sides of the triangle. If built properly, the ends of the perpendiculars intersect at one point **O'.**
6. Connecting the dots **O** and **O'** get **EMF** vector heart.
7. Through the center of the triangle spend a horizontal line.
8. Determine the angle of the electrical axis of heart with respect to the horizontal line with a protractor.



2. **Calculation of voltage teeth** (this is a translation of the amplitude of the wave of **mm** in **mV**).

1. Glue calibration pulse.



2. To calculate the voltage spike R measure the amplitude in mm.
Using the parameters of the calibration signal (amplitude and the voltage of **1 mV**), make proportion: $\mathbf{A_k}$ **- 1 mV**

$\mathbf{A_{R1}}$ **- x mV**,

where $\mathbf{A_k}$ - amplitude calibration signal

$\mathbf{A_{R1}}$ - amplitude of the signal.

Then the amplitude of the signal will be equal to X(**mV**)= $\frac{A_{R1} \cdot 1mB}{A_k}$

3. Calculate the voltage teeth R in all three leads.
4. Enter data in the table:

Allotment	The amplitude of the gauge signal in **mm**	The amplitude of the gauge signal in **mV**	The amplitude of the wave in **mm**	The amplitude of the wave in **mV**	The angle of the electrical axis of heart
1					
2					
3					

Conclusion:

2. **Calculation of time intervals** (this is a translation of the duration of the wave, the segment interval of **mm in seconds**).

8. Glue ECG fragment containing the two periods.

2.For the calculation of temporal characteristics specify the speed of the recording of the ECG.

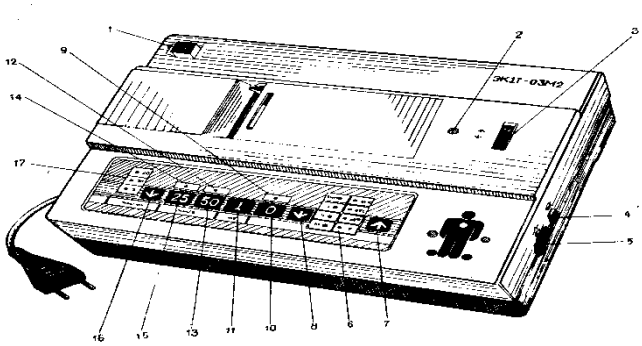
3. Measure **mm** distance between interesting points on the **t** axis.

4. The data obtained substitute formula $t = \frac{S}{V}$.

4.Enter data in the table:

№	View teeth segment, interval	Speed **ECG** recording	The duration of teeth in **mm**	The duration of teeth in **seconds**
1	**R-R**			
2	**P**			
3	**T**			
Conclusion:				

2. Unit and work electrocardiograph



1. **Unit ECG recorder (Fig 7)**
   Controls and indicators modes

1 - power supply;
2 - battery discharge indicator
3 - regulator offset pen;
4. switch type of work.
5 - plug connection cable of assignment;
6 - indicators of the switch leads;
7 - switching button leads in reverse sequence " ↑";
8 - button switch lead in direct sequence" ↓ ";
9 - activation indicator calm (turns on when a calm);
10 power button calm " **0** ";
11 - power calibration voltage "**1 mV**";
12 - activation indicator of speed of movement of the recording media to **50 mm** (lights up when you turn on);
13 - button on the speed of **50 mm/s " 50 ";**
14 - indicator of the speed of movement of the recording medium is **25 mm/s** (when you turn on the lights);
15 - button on speed of **25 mm/s " 25 ";**
16 - button switching the sensitivity **ECG**;
17 - sensitivity indicators (lights **1** of indicators suitable enabled sensitivity **ECG**).

3. Practical part:

1. Turn on the system by pressing the power button, which should fix itself in the lower position. When this should be illuminated: power indicator calm, one of the indicators of the sensitivity of the apparatus and the switch led displayer, indicating the inclusion of gauge derivations "**1mV**".
2. Select the sensitivity of an electrocardiograph **10 mm/mV**, pressing the button switch sensitivity.
3. Install a thermal pen into the midst of the fields in the record regulator offset pen.
4. Turn off the sedation, briefly press the power button and calm.
5. Turn on the withdrawal of the diagram tape with the speed of **25 mm/s**, briefly pressing the on speed «**25**».

6. Note 2 - 3 calibration signal, briefly press the calibration button «**1мV**» indicating the sensitivity of the apparatus.
7. Turn off the withdrawal of the tape, briefly pressing the on speed "**25**".
8. Select leads in position "**1**", briefly press the button switch leads "↑".
9.Turn on the wire diagram tape with the necessary speed and record the required number of cycles of electrocardiograms.
10. Record electrocardiogram in other leads, installing the switch lead in subsequent diversion by briefly pressing the button « ↑».

Control questions:
1. Give the definition of electrocardiography.
2. Explain the scheme of the emergence and spread of biopotentials heart.
3. Describe the basic components of the conduction system of the heart (sketch). The main provisions Einthoven theory.
4. Call diversion by Einthoven.
5. Sketched electrocardiogram healthy heart, to explain the origin of teeth intervals, segments.
6. Explain block diagram of the electrocardiograph. Purpose blocks. Explain procedure ECG.
7. Explain construction EMF vector hearts.
8. Explain the methodology for determining the voltage of the teeth, and calculating the time of ECG intervals.
9. Explain the role of electrocardiography in clinical and experimental medicine.

Literature:
1. Paul Davidovits «Physics in Biology and Medicine», Third Edition, 2008, chapter:14.2, 14.2.1, page 202-203.
2. Lecture on the topic: «**Physical Basis of Electrocardiography**».

Tests on: «Physical Basis of Electrocardiography»

1. Electrocardiography is to register:
1. the electrical activity of the brain
2. potential difference, changing over time due to the electrical activity of the heart
3. potential difference arising in the functioning of an organ
4. potential difference, changing over time due to the electrical activity of the brain.

2. **P wave on elektrokadiogramme means:**
a) atrial excitation
b) initiation of the interventricular septum
a) the full excitement of both ventricles
g) the almost complete excitation of both ventricles
e) the processes of repolarization

3. **Set the sequence of formation of teeth on ECG during propagation of excitation in different areas of the neuromuscular system of the heart:**
   1. S
   2. Q
   3. R
   4. T
   5. P
4. **The second leads in electrocardiogram recorded between:**
   1. Left hand-left foot
   2. Right hand-left foot
   3. Right hand-left hand
5. **When registration of the electrocardiogram take place the total number of leads:**
   1. three
   2. six
   3. twelve
   4. ten
6. **Electrocardiograph by action principle is:**
   1. generator of electrical oscillations
   2. AC rectifier
   3. amp electrical oscillations
   4. rectangular pulse generator standard
7. **Set the order of the blocks in the block diagram of the ECG:**
   1. recording device
   2. bass booster
   3. the unit leads
   4. differential amplifier
   5. power amplifier
8. **Q wave on elektrokadiogramme means:**
   1. atrial excitation
   2. initiation of the interventricular septum
   3. the full excitement of both ventricles
   4. the almost complete excitation of both ventricles
   5. the processes of repolarization
9. **Crosstalk signals is :**
   1. distort the shape of the desired signal
   2. reinforcing the desired signal
   3. reducing the useful signal
   4. not affecting the shape of the desired signal

10. **Set the sequence of excitation of propagation various areas the neuromuscular system of the heart:**

1. ventriculonector

2. sinus node
3. Purkinje fibers
4. atrioventricular node
5. bundle branch block

Module № 3

Laboratory work № 9

Determination of the Concentration of Substances in Solutions Using the Photoelectric Colorimeter of Concentration KFK-2

1. The purpose of the work:

1. The study photo electric method for the colorimetric determination of concentration of colored solutions.

2. Instruments and accessories:

1.Kolorimetr photovoltaic concentration of CK-2.
2**.** The cell.
3. Solutions of the investigated substances with different concentration.
4. A solution unknown concentration**.**

3. **Theoretical introduction:**

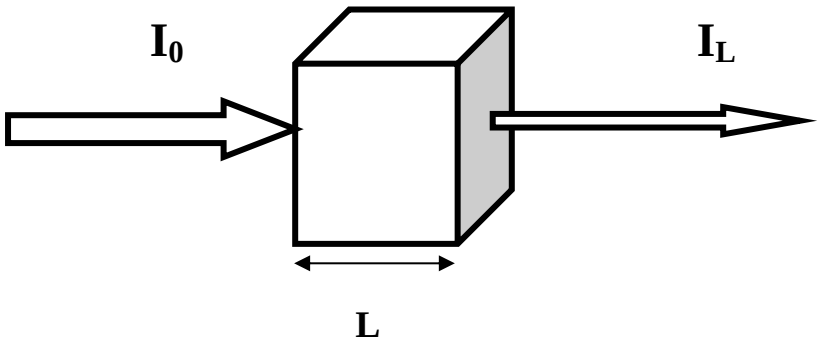
KFK-2 photoelectric colorimeter of concentration is designed for measuring the coefficients of light transmission and an optical density of liquid solutions and of solids, as well as the determination of the concentration of substances in solutions by the method of construction of calibration graphs, in some areas of the range of wavelengths (315-980 nm)allocated filters.

Colorimeter also allows the measurement of light transmission coefficients scattering suspensions, emulsions and colloidal solutions in transmitted light. Photos electro colorimetric method for determining the concentration of substances in solution is widely used in clinical laboratory diagnosis . For example , the quantitative determination of protein in urine to determine the concentration of hemoglobin in blood, the determination of total protein in blood serum, etc.

The basis of the work of photoelectrocolorimeters is a law of absorption of light by material.

When the light intensity $\mathbf{I_0}$ passed through the solution **L**, its intensity decreases and becomes equal to $\mathbf{I_L}$. Intensity reduction is a consequence of the interaction of light waves with electrons of matter, in which part of the energy of the light wave

is transmitted to electrons. This phenomenon is called the absorption of light. Consider the law of absorption of light by matter.



$$I_L = I_0 \cdot e^{-\chi_\lambda \cdot L}$$

Where**:** $\mathbf{I_L}$-intensity of light, passing substance layer by thickness L,
Io-intensity of the incoming light in the environment,
χ_λ-monochromatic natural absorption coefficient, which depends on the properties of the environment;
The sign "-" means that the light intensity decreases.

Light of different wavelengths absorbed by a substance also different, so the absorption coefficient χ_λ is dependent from wave length.

Monochromatic natural absorption rate of the solution in a non-absorbing material absorbing solvent is proportional to the concentration of the solution (**Beer's law**):

$\chi_\lambda = \chi_c \cdot c$ where χ_c -monochromatic absorption coefficient.

Beer's law holds only for dilute solutions. Combining laws Bugera and Bera we obtain the **law of the Bouguer-Lambert-Bera.**

$$I_L = I_0 \cdot e^{-\chi_c \cdot c \cdot L}$$

$\tau = \frac{I_L}{I_0}$ - is called the coefficient of light transmission.

The optical density of the substance is: $D = \ln \frac{1}{\tau} = \ln \frac{I_0}{I_L} = \chi \cdot c \cdot L$

The law of the **Bouguer-Lambert-Bera** is the basis of the concentration of colorimetry.

4. Device CK-2

In the optical unit includes:

1. Illuminator

2.Frame with optics (condenser)

3.Lightfilter -colored. Filters mounted in the drive. Filter into the light beam is introduced by handle "filters." Working position of each filter is fixed.

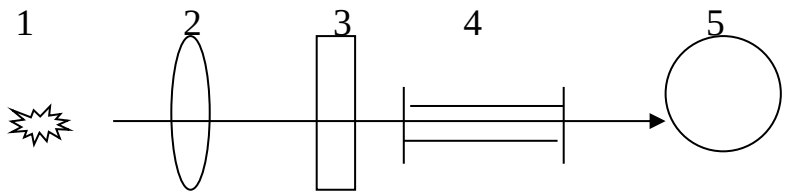
In this instrument we uses the following filters (see Table. № 1).

№ filter	λ (nm) filter	№ filter	λ (nm) filter
1	315	6	540
2	364	7	590
3	400	8	670
4	440	9	750
5	490	10	870

4. Holder of cell.
5. Fotometrical device.
6. The apparatus of registration. As the recording device applied microammeter, with the scale digitized in the coefficients of bandwidth τ and optical density **D**.

5. Principle of work of CFK-2

The light beam from the light source (1), a condenser (2) through the filter (3) is directed on the cell with the test solution (4).



The light flux passing through the cuvette with the solution is converted into an electrical signal by the photodetectors (5).
The resulting electrical signal is fed to a DC amplifier and then to the meter readings are proportional to the light flux passing through the test solution.

6. The order of execution of work

I. Preparation for work

1.Kolorimetr enable network 15 min before beginning measurements. During warm-up sample compartment must be opened.
2.Insert for measurements required by need of a deal colored filter.
3.Set the minimum sensitivity of the colorimeter.
To do this: a) handle "sensitivity" to position "1"
b) handle "set roughly 100"-to the extreme left.
4.Before measurements and switching photodetectors verify the installation arrows colorimeter to "0" on the scale transmittance τ with an open sample compartment. By moving the pointer from its zero position sum to zero by the potentiometer "zero", derived under the slot.

II. The work with the device

1.In the light beam to put a cell with a control solution.
2.Do close the sample compartment cover.
3.By buttons(knobs) do select "sensitivity" and "setting 100 coarse and fine" set countdown 100 colorimeter scale (handle "sensitivity" can be in one of three positions: "1", "2", "3".).
4.Later on by turning the cuvette cell holder with a solvent to replace the cell with the test solution.
5. Do scale reading of the test solution τ bandwidth percentage and absorbance of the solution.

III. Determination of the concentration of substances in solution

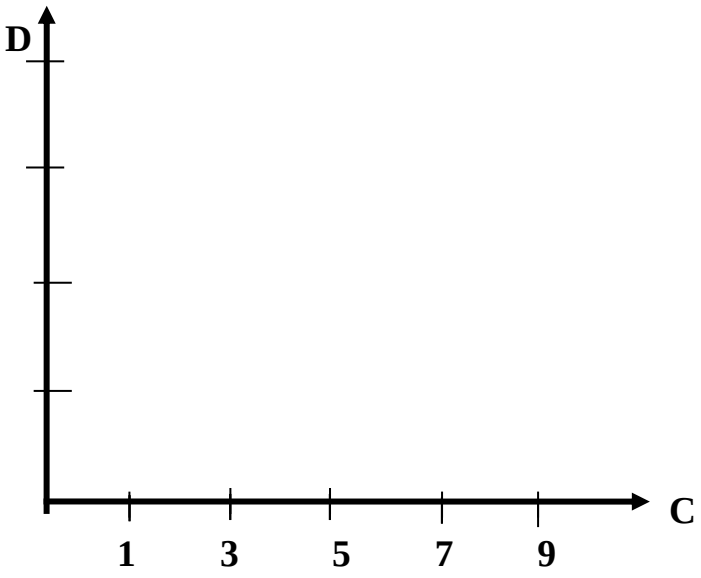
To determine the concentration of a substance in the solution should be observed in the following sequence.

1. Construction of the calibration curve for the substance

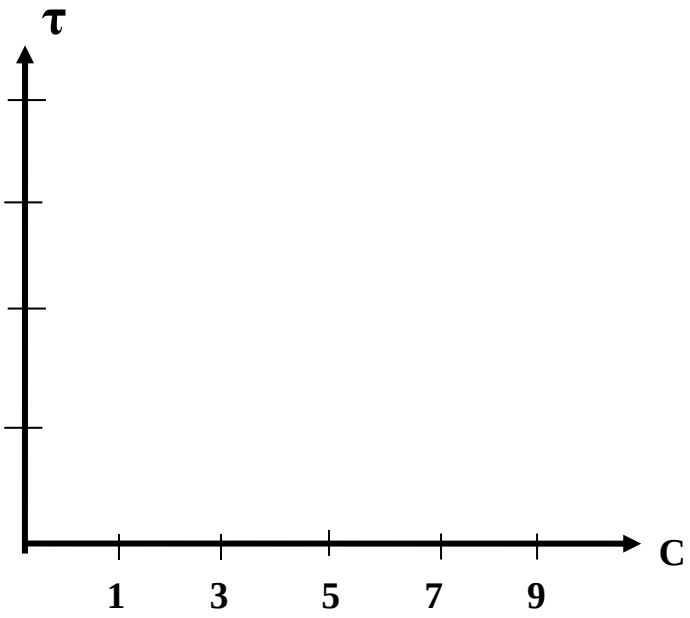
a) Measure the optical density and the light transmission of all solutions, the concentrations of which are known to you, at the selected wavelength.
b) Measure the absorbance and light transmission of the solution of unknown concentration.

wavelength λ	**solution strength** **C%**	**optical density of the solution** **D**	**light transmission** τ
	1 %		
	3 %		
	5 %		
	7 %		
	9 %		
	C_x%		

b) Construct a calibration curve by plotting known concentrations of the horizontal axis and the vertical - the corresponding values of absorbance.



d) Construct a calibration curve by plotting known concentrations of the horizontal axis and the vertical - the corresponding light transmission value of the coefficient.



4) Determination of the concentration of a substance in solution

a) Pour the solution of unknown concentration in the cell, to determine the optical density of the solution.

b) By graduative curve do find the concentration corresponding to the measured value of the optical density.

Conclusion:

The control questions

1.For which used photoelectric colorimeter concentration?
2.Name a scope fotoelectrocolorimetrical method.
3.Essence phenomena of light absorption material. Bouguer law.
5. Formulate Beer's law.
6.Write formula Bouguer law-Lambert.
7.Do deferminate a light transmission and optical density of the substance.
8.Do descrabe a mechanism and operation of CK-2.
9.How build graduative curve for a given substance.
10.How to determine the concentration of a substance in a solution?

Literature:

3. Paul Davidovits «Physics in Biology and Medicine», Third Edition, 2008, chapter:14.2, 14.2.1, page 202-203.
4. Lecture on the topic: «**Physical Basis of Electrocardiography**».

Tests on: Determination of the Concentration of Substances in Solutions Using the Photoelectric Colorimeter of Concentration KFK-2

1. **The ratio of the intensity of the transmitted through a solution of light to the intensity incident on the solution of the light is called the coefficient of:**
   1. absorption
   2. reflection
   3. scattering
   4. light transmission
2. **The unit of measurement of light transmission is:**
   1. percentage
   2. lux
   3. mA
   4. candella
3. **The light of different wavelengths is absorbed by the substance:**
   1. fully
   2. variously
   3. equally
4. **As the recording device in the apparatus used by the FEC:**
   1. voltmeter
   2. microammeter
   3.luxmeter
   4. Photocell
5. **The solar cell is a device that:**
   1. increases the luminous flux
   2. convert luminous flux into electric current
   3. measures luminous flux
   4. convert luminous flux in a magnetic field
6. **A filter is a device that transmits light**
   1. all wavelengths
   2. certain intensity
   3. certain wavelength
   4. certain power
7. **The optical density of the substance:**
   1. proportional to the concentration and thickness of a layer of a substance
   2. proportional to the coefficient of light transmission
   3. inversely proportional to the concentration and thickness of a layer of a substance
   4. inversely proportional to the concentration and thickness of a layer of a substance
8. **The Law of Bera**:
   1. $I_L = I_0 \cdot e^{-\chi_\lambda \cdot L}$

2. $\tau = \frac{I_L}{I_0}$

3. $\chi_\lambda = \chi_c \cdot c$

4. $dI = -\chi_\lambda \cdot I \cdot dL$

9. **Place the blocks of optical system of the FEC in order:**
   1. photocell
   2. the evaluation unit
   3. illuminator
   4. cuvette with a solution
   5. rim with optics (condenser)
   6. Filters

10. **Calibration curve cost values:**
   1. optical density of the solution of known concentration
   2. optical density of solutions of unknown concentration
   3. solution concentration
   4. the coefficients of solution light transmission unknown concentration

Laboratory work № 10
Hygienic Assessment of a Natural and an Artificial Lighting
The purpose of the work:

1) familiarize the students with the hygienic requirements for natural and artificial lighting of premises of treatment-and-prophylactic establishments.
2) study the photometric units.
3) learn how to detect the illumination of premises with the help of a light meter.
4) do learn to calculate the required number of lamps to generate a given level of artificial light in the room.

Devices:

1.The Lux meter (ATT-1508).

A theoretical introduction:

The visible part of the solar spectrum have a great biological importance. Daylight has a beneficial effect on the mental condition of the person, especially of the patient. Under its influence, increases the body's metabolism, the synthesis of some vitamins, improves blood processes, the work of the endocrine glands etc.
The illumination mode plays a significant role in regulation of biological rhythms. In the conditions of the light intensity there are improves a growth and a

development of the organism. The intensity of illumination of a workplace is of great importance for the prevention of disturbances of vision, particularly when a working requiring an eyestrain. Inefficient lighting lead to the development of myopia. When bad or wrong lighting lead to reduced mental capacity, faster the fatigue, motor coordination deteriorates. Due to the large physiological role of the visible part of the solar spectrum, all the premises of treatment-and-prophylactic establishments which intended for long-staying patients must have natural illumination. In case of insufficient natural light (in dark time of the day and if the weather is bad), and also if to create additional lighting in the workplace when should be used artificial light sources.

The main photometric characteristics

Power light energy refers to the amount of energy transferred electromagnetic wave through this surface per second.

$$W=E/t$$

Visual sense of the eye depends not only on the radiation power, but also from the spectral sensitivity of the eye (visibility factor). Therefore, it may be more convenient to characterize the light emission piece as product of **radiation power - W** on the **visibility factor - V**.

Visibility factor is psychophysical, or photometric characteristics of radiation, taking into account the spectral sensitivity of the eye.

Luminous flux Φ is defined as a product of the radiation power by a factor of liquidity profile.

$$\Phi=W*V$$

Lumen - luminous flux emitted by a point source in a solid angle **1sr** when light intensity of **1 cd**.

$$\Phi=I \cdot \Omega$$

For a quantitative estimation of illumination of the surface introduces the concept of lighting.

The illumination surface is the ratio of luminous flux incident on the surface, to the amount of such surface, i.e.

$$E=\Phi/S$$

Lux is the illumination of the surface area of **1 m^2** by luminous the luminous flux of **1 lm**, falling perpendicular to the surface.

For unit of illumination is accepted **lux (lx).**

The illumination created by direct sunlight, is of the order of **10 lx**, illumination required reading is about **40 lx** illumination created by a full moon, is **0.2 lx**.

At hygiene the illumination is used then to assess the lighting. The illumination shall be measured with the help of the device-Lux.

Description of the device for measuring light (ATT-1508)

The Lux meter is a portable device of type display on the LCD. The device is a photodiode special type of filter color correction. The device provides high accuracy of measurements and allows the user to measure illumination in an optimal manner.

The front panel

1. Display;
2. Hold the testimony;
3. Switch the device, select measurement range;
4. Compartment battery with cover;
5. Light sensor;
6. Setting zero.

Rules of work with the device for measuring light (ATT-1508)

1.Switch.

2.Direct the sensor against the measured flow. The display can be considered as the value of illumination.

3. If the selected measurement range **1999 lux**, and the measured value of the illumination of less than **200 lux**, you should use the switch range select switch the device on the lower range in order to achieve a high resolution and accuracy of measurements.

4.To same for measurements in the range **19990 lux**. The device must be switched to a lower range if the measured value of the illumination of less than **2000 lux**.

The practical part

1. Install the device in a horizontal position.
2. Connect the solar cells to measure.
3. Measurements should avoid prolonged exposure to light, exceeding the lux meter limit of light.
4. To avoid overload search meter limit of measurement should always be started with the limit **19990 lux**, consistently moving on to more sensitive measurement limits until the pointer is in the working part of the scale.

Task №1: Determination of illumination

1. Determine the illumination of workplaces in the laboratory, created mixed lighting (natural and artificial).

2. Determine the natural illumination of working places (when the lamps switched off the lamps).
3. Determine the illumination of workplaces created by the artificial lighting (the difference between native and natural light).
4. The results of the work summarized in a table:

Mixed light, both (natural and artificial) lux	**Natural illumination lux**	**Artificial illumination lux**	**Norm light lux**
Conclusion:			

Task №2: Calculation of necessary quantity of luminaires

1. Calculate the required number of lamps to generate a given level of artificial light in the room.

Determination of necessary quantity of lamps to generate a given level of artificial light in the room you can spend calculated using the tables of specific power (power density-the ratio of the total power of the lamps for the area of the floor (**W/m^2**)

Do find power density find on the tables at the intersection of the horizontal line, the corresponding area of the premises and suspension heights of lamps and a vertical line corresponding to a given level of illumination.

1. To determine the required number of lamps to obtained a value of the specific power to multiply the size of the premises and to share the power of a single bulb.

(**40 W**). $$N = \frac{J \cdot S}{P}$$

2. The results of the work summarized in a table:

H (м)	**S (м^2)**	**Illumination E**	**Power density J**	**the power of one lamp P**	**Number of lamps N**
Conclusion:					

Table № 1

The specific power of the general uniform lighting (W/m^2) (fluorescent lamps)

H(м)	**S(м^2)**	**Illuminance (lux)**						
		75	**100**	**150**	**200**	**300**	**400**	**500**
3-4	10-15	12,5	16,8	25	33	50	67	84
3-4	15-20	10,3	13,8	20,7	27,6	41	65	69
3-4	20-30	8,6	11,3	17,2	23	35	46	58
3-4	30-50	7,3	9,7	14,2	19,4	29	39	49
3-4	50-120	5,9	7,8	11,7	15,6	23	31	39

Table №2

Illumination (lx) for lamps of different capacity

Lamp power (W)	**light (lx)**
75	36
100	42
150	50
220	55
300	61
500	55

Table № 3

Norms of artificial lighting

Residential public buildings and auxiliary facilities	**Illumination in lux**	
	Fluorescent lamps	**Incandescent lamps**
1. Residential rooms in the apartments	100	50
2. Bedrooms in hostels	100	50
3. The audience classes educational rooms and laboratories	300	150
4. Sports halls	200	75
5. Game rooms in kindergartens and crèches	200	100
6. Operating in hospitals	400	200
7. Physicians offices	300-500	150-200
8. The chamber of hospitals and sanatoriums	100-150	50-75
9. Diagnostic laboratories	300	150
10. The main corridors and passages in hospitals and schools	75	30

Control questions

1. Give the definition of the flow of light energy.
2. Give a definition of a light stream.

3. The unit of luminous flux lumens.
4. Give a definition of light.
5. Formula light created by a point light source.
6. The unit of light-lux.
7. The device is light meter.
8. Rules of the use by a Lux meter.
9. Calculation of the necessary quantity of luminaires.

Literature:

5. Paul Davidovits «Physics in Biology and Medicine», Third Edition, 2008, chapter:14.2, 14.2.1, page 202-203.
6. Lecture on the topic: «**Physical Basis of Electrocardiography**».

Tests on: Hygienic Assessment of a Natural and an Artificial Lighting

1. Light is electromagnetic waves with a wavelength of:
1. 400-10 nm
2. 1000-0,78 microns
3. order of several decimeters
4. 780-400 nm

2. The main parts of lux meter is:
1. The measuring device (sensitive galvanometer) and photocell with nozzles
2. Selenium photocell attachments
3. Measuring device

3. The strength of the light is calculated by the formula:
1. $E=\Phi/S$
2. $\Phi=I \cdot \Omega$
3. $I=\Phi/\omega$

4. The most sensitive eyes has to:
1. white light
2. red light
3. green light
4. purple light

5. A unit of the strength of the light is:
1. lumen
2. lux
3. candela

6. The illumination measured by:
1. photoelectrocolorimeter
2. the Lux meter
3. photocell
4. galvanometer

7. What characteristics of the light wave determines the color sense?
1. wavelength

2. the speed of propagation
3. intensity
4. energy flow

8. The solar cell is a device:

1. let light of a certain wavelength
2. convert luminous flux into electric current
3. let light of a particular color

9. A unit of illumination is:

1. lumen
2. lux
3. candela

10. Luminous flux is calculated by the formula:

1. $E=\Phi/S$
2. $\Phi=I \cdot \Omega$
3. $I=\Phi/\Omega$

Laboratory work № 11

The Definition of Radioactive Background Using the Radioactivity Indicator RADEX KMG 1503

Objective:

Do learn the basic forms of ionizing radiation according to their impact on biological and non-biological objects.

Apliances:

1. Radioactivity indicator RADEX RD 1503
2. Check source of B-8

Theoretical introduction:

I. Types of a ionizing radiation

An ionizing is called a radiation which in given substance can cause ionization, i.e. able to pull an electron from the atom.

An ionizing radiation is divided into two parts:

1) ionizing radiation in the form of particles flying with great speed, and therefore with great energy;

2) ionizing radiation in the form of short-wave electromagnetic radiation.

The first type of ionizing radiation include: fast-moving electrons or positrons (β-particle) beams of protons and nuclei of recoil that resulting from the nuclear reactions.

2. Dosimetry of ionizing radiation

Ionizing radiation can cause biological effects and is therefore used in medicine for diagnosis and treatment.

To assess the degree of ionizing radiation on the objects animate and inanimate nature is necessary to measure the impact of radiation on the object under study, i.e. solve problems of dosimetry.

Dose are introduced for the measurement of ionizing radiation:

1. absorbed dose
2. exposure dose
3. equivalent dose
4. effective dose equivalent
5. collective effective dose equivalent
6. total collective effective dose equivalent

1.Absorbed dose is based on the fact that when a body to irradiate by ionizing radiation, it is passed energy ionizing radiation to the body and the energy of the increases (or else the body heats up).

Absorbed dose is the quantity Dp numerically equal to the energy of ionizing radiation absorbed by a unit of body weight:

$$D_n = \frac{E}{m}$$

The unit of absorbed dose in **SI** units is the gray (**Gy**).

1 Gray - it's such absorbed dose at which one kilogram of irradiated body is the energy of ionizing radiation equal 1Joule.

1Gy = 1Joule/1kg

Off-system units of the absorbed dose is - rd.

1 Gr = 100 rd

The disadvantage of method is that the measure an absorbed dose is technically very difficult.

So absorbed dose to the measure most often not by the direct method, but by indirect methods (chemical, fluorescent etc.)

Ease of measurement of absorbed dose in rads, that consists in the fact which is a water and water-based fabrics has a very simple relationship between the absorbed dose, expressed in rad and exposure dose in roentgens expressed.

2.Eksposure dose of ionizing radiation quantitative characteristic based on the magnitude of the ionization of dry air at atmospheric pressure.

Exposure dose is the quantity that is numerically equal to the amount of charge of each character appearing in a unit mass of dry air at its full ionization.

D_o=Q/m

Per unit of exposure dose in SI units accepted **1Kl/kg**.

1Kl/kg- this dose, under the influence of which upon full ionization, 1 kg of dry air under normal conditions, a total charge equal **1kl.**

Often used off-system unit exposure dose is Roentgen.

1 Roentgen (R) - is such exposure dose at which occurs in 1 cm3 of the total ionization of air under normal conditions and formed 2.1 billion pairs of ions.

Dose of 1 roentgen is created radioactive Ra_{88}^{226} mass of 1 g (=1ki) for 1 hour at a distance of 1meter.

Between exposure and absorbed dose relationship exists:

$D_p = f \cdot D_o$

where **f**-proportionality factor depending on the environment in which the comparison of **D_p and D_o.**

If the absorbed dose is measured in rad and measure the exposure dose in roentgen, for air **f =0,88**; for water **f = 1**.

Water and soft tissues of the human body **f=1**, hence radiation absorbed dose in rads is numerically equal to the exposure dose in roentgen.

3. **Equivalent** (or biological) **(De) dose**

Different types of ionizing radiation absorbed dose for the same **have different biological effects.**

For example, if two biological tissue respectively irradiate X-ray and proton beam of the same dose, the tissue irradiated by a proton beam will be struck 10 times more than the tissue irradiated by X-ray irradiation.

The smallest biological effect has X-ray and gamma radiation. All other types of ionizing radiation have a greater biological effect.

For comparison of the biological action of different types of ionizing radiation is used quality factor-**QC.**

QC shows how many times this type of radiation has a stronger biological effects than X-ray or gamma-ray absorption at the same energy in one gram of tissue.

Biological effects of ionizing radiation on tissue evaluated in **Sievert** (Sv) and **ber** (off-system unit).

Ber - biological equivalent of rd. **1Zv = 100ber**

1 Ber - 1 quantity of energy absorbed per 1 g of tissue, in which there is the same biological effect as a dose of radiation absorbed at 1 rad of X-ray or gamma radiation.

Value QC of various kinds of radiation are shown in Table №1.

Type of radiation	QC
1. Gamma, X-rays	1
2. Beta – particles	1
3. Protons and particles	10
4 Alpha radiation	20
5. Thermal neutrons	3
6. Fast neutrons	10

The absorbed dose and biological related by **$D_{ekv} = QC \cdot D_p$**

Then for X-ray or gamma radiation turns out that 1 rad of X-rays produces a biological effect in rem 1. 1rad multiply charged ions (eg, alpha particles) create a biological effect in 20 ber.

With a single action of radiation on the human body all the result of the action is mainly determined by the total absorbed dose. The higher the total absorbed dose, the harder it will be the consequences for the organism.

Table №2

dose in rd	Effect on human
1. **0 – 25**	No apparent violations
2. **25 – 50**	Possible changes in the blood
3. **50 – 100**	Changes in the blood, the normal state disability violated
4. **100 – 200**	Possible loss of earning capacity
5. **200 – 400**	Disability, possibly fatal
6. **400 – 500**	Fatalities account for 50% of the total number of victims
7. **600 and more**	Lethal cases 100%

4. Effective dose equivalent (D_{ee})

D_{ee}-characterizes the cumulative effect of which has ionizing radiation on the human body as a whole, given that different bodies have different sensitivities (defect) ionizing radiation.

Most strongly affected the red bone marrow and gonads, and, for example, nervous tissue is very stable.

$$D_{ээ}=\sum КРР \cdot D_{экв}$$

CRC-radiation risk factors (see Table 3).

tissue	CRC
Red marrow	0,12
Lungs	0,12
Mammary gland	0,15
Ovaries (testes)	0,25
Thyroid	0,03
Bone	0,03
Other tissues	0,3
Organism as a whole	1,0

Thus, if you know what organs and what doses of irradiated (this is especially important when entering radioactivity with food, water, inhaled air with subsequent accumulation in certain organs) and identified risk factors, we can calculate the effective dose equivalent received by man.

Effective dose equivalent measured in **Sievert** (**Sv**) and **ber** (off-system unit).

4. **The collective effective dose equivalent (DKEE) objective assessment of the scale of radiation damage**

$D_{кээ}=D^{1}_{ээ}+D^{2}_{ээ}+\ldots+D^{n}_{ээ}$

$D_{КЕЕ}$-characterizes the damaging effect on the population as a whole. Unit-**man-sievert.**

5. Full collective effective dose equivalent (D_{pke}) characterizes the damaging effect that a generation of the population of people living in the area of radiation for all subsequent years of life.

If a number of people continue to live in long-term chronic exposure to known patterns and changes in radiactive forcing, to calculate expected collective effective dose equivalent for a certain period of time coming.

Dose rate

Dose rate is called the physical quantity is equal to the radiation dose received by a unit of body weight per unit time.

P = W/t [P] = W/kg [P] = rd/s

Exposure dose is measured in **A/kg** (Ampere per kg).

Off-system unit **P/s, mR/s, mkR/s, R/h.**

With further expansion of the application of radioisotopes in science, technology, industry, medicine, etc. increasing number of people working in environments with high levels of radiation directly exposed to dangerous radiation. In this regard, it is important to carry out systematic monitoring of their health and, in particular, to measure the resulting organism per working day dose radiation. For these purposes are different dosimeters.

To measure the dose using different types of X-ray devices (roentgenometer).

Radioactivity indicator RADEX RD 1503

Radioactivity indicator RADEX RD-1503 power meter is designed to measure the dose levels of gamma - beta radiation and radioactive contamination of various subjects gamma - beta radiation (Figure 1).

The exterior of radioactivity indicator RADEX RD 1503

1. LCD - display.
2. The "Menu" and its icon on the display. A button has three functions: "MENU", "SELECT", "CHANGE".
3. Button "CURSOR" and its icon on the display. Button is used to move the cursor to the menu.

4. Button to "OFF" and its icon on the display. The button has four functions: including products, including LCD backlight, return to the menu, turn off the product.
5. The battery compartment.
Pictograms do show to the user function of keys, thereby facilitating the use of the product.

Operation

1. Turn on the device

Click the big button **"OFF"**, then the display turns "screen RD 1503" Begins evaluation of the radiological situation.

2. **Result**

Result of observation (dose) appears on the display after 10 seconds.

3. **Enter the menu**

To access the menu and change the factory settings, press the "MENU". Content menu appears. By default, the following settings:

- The dimension - mSv/h
- Threshold - 0.3 mSv/h
- Sound - quiet
- Lights - off.

4. **Navigating through menus**

Navigating the menu is made with the **"CURSOR"**. Selecting a menu item and the change is made with the **"MENU"**.

5. **Exits the menu. Shutdown**

The menu is longer (up to the message on the display) by pressing the "OFF".

Using indicator radioactivity RADEX RD 1503

For further evaluation

After switching products do begins an evaluation of the radiological situation. During the observation period, each detected photon emission is accompanied by a display on the display icon «■» and a short beep when the sound is turned on and turned off threshold. The frequency of the icons on the display is proportional to dose.
After 10 sec. after the products on display shows the first result of short cycle Short cycle observation is 10 seconds. and is designed for quick preliminary results. The most significant result is displayed after the first 40 seconds. monitoring cycle and displays the icon «|».
Second and third cycles of short observation automatically averaged.

How to conduct a survey

In assessing the radiation environment must be remembered that ionizing radiation has a statistical, probabilistic nature, so reading articles in the same conditions can not remain strictly constant. For reliable determination of the dose rate level should be 3 to 5 cycles of observation without turning off the product.
In determining the radioactive contamination of food, household items, etc. should bring the product to an object at a distance of 5-10 survey mm left side (with slots) and turn it on.

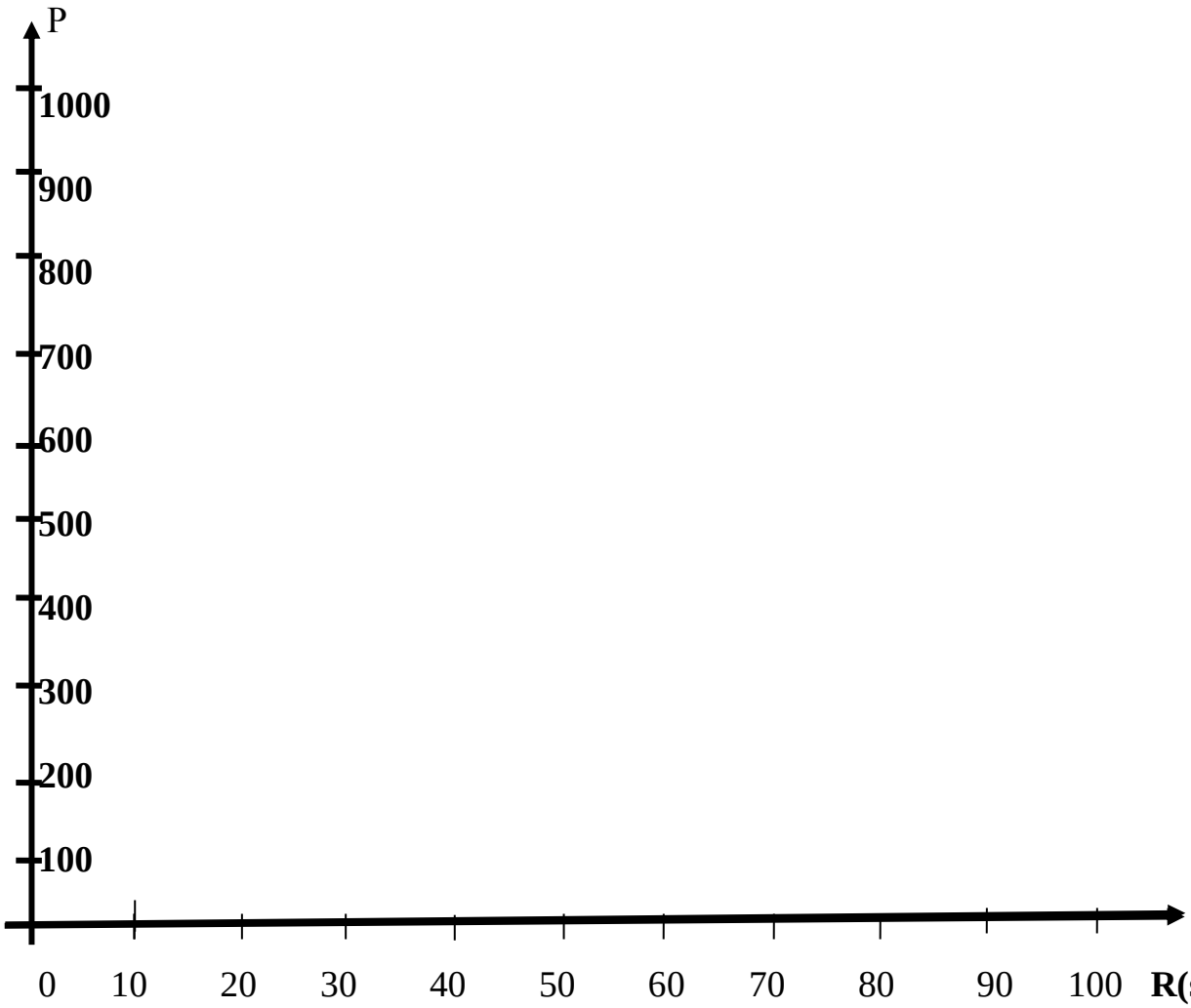
In determining the radioactive contamination of fluids dose assessment carried out over the exposed surface of the liquid. Do not allow liquids to the surface and inside of the product. To protect the product in such cases it is recommended to use a plastic bag, but no more than one layer.
To determine the location of the source of ionizing radiation should be included to move the product over the surface of the inspected object, focusing on the frequency of sound signals (in the settings menu: threshold - off, Up - included). Remember that the frequency of the signal as it approaches the source will increase sharply, and as the distance was also sharply decrease.

The practical part of the work

I. Determination of the air layer of half and full absorption β radiation source

1. Measure the dose rate at a distance from 0 to 100 sm every 5 sm from the source of radiation.
2. Data recorded in the table and plotted dose of air layer thickness.

The thickness of the air layer (sm)	**The dose rate (mR / hr)**	**The thickness of the air layer (sm)**	**The dose rate (mR / hr)**
0		55	
5		60	
10		65	
15		70	
20		75	
25		80	
30		85	
35		90	
40		95	
45		100	
50			



1. According to the schedule to determine the thickness of the air layer of half and full absorption of beta radiation.
2. Data recorded in the table below:

Air layer thickness half-absorption of beta radiation **sm**	**The thickness of the layer of air of complete absorption of beta radiation** **sm**
Conclusion:	

II. Determination of the maximum permissible safe residence time in the field of human beta and gamma - radiation.

We are interested in a safe duration of time during which a person may be about isotope.

To perform the calculations we use the formula:

$$P = D_{pr}/t$$

However, note that the maximum safe dose per working day for those working directly with radioactive sources is **0.017 R.**

We express this dose **mR:**

$D_{пр.}$ =0.017 P=17·10^{-3}P=17·10^{-3} ·10^{6} mkR =17·10^{3} mkR

To measure the location near the source of radiation in hours necessary to measure the dose produced by the source (Ri), and then calculate the time safe location near the source of radiation directly to the clock by the formula: **P** = $\mathbf{D_{pr}}$/ t t = $\mathbf{D_{pr}}$**/ P**.

The measurement results tabulated:

№	Distance between the dosimeter and source of gamma – radiation **sm**	Meaning dose rate **(mkR/hr)**	Maximum permissible exposure time **hour**
1.			
2.			
Conclusion:			

The control questions

1. Types of ionizing radiation.
2. Determination of alpha, beta and gamma radiations.
3. Define doses of ionizing radiation:
   - absorbed dose
   - exposure dose
   - equivalent dose
   - effective dose equivalent

4 . Define unit doses of ionizing radiation.

5 . Dose rate units.

6. Biological Effects of Ionizing Radiation.

7. Preparing for radioactivity indicator " RADEX RD 1503 " and work with him.

1. Radiation interaction with matter which leads to ionization of atoms and molecules, called:

1 ionizing

2.kosmicheskim

3.thermal

2. The dosage which takes into account the biological effect of various types of radiation absorbed at the same dose, called:

1. exposure dose

2. equivalent dose
3. absorbed dose

3. **The absorbed dose in the SI system is measured in**:
   1. Gray
   2. Coulomb on a kg
   3. Sievert
   4. man-sievert
4. **Off-system unit exposure dose:**
   1. rd
   2. ber
   3. Roentgen
5. **The radiation dose at which the substance is irradiated 1 kg transmitted ionizing radiation energy of 1J, is:**
   1. 1 Roentgen
   2. 1 Gray
   3. 1 Sievert
   4. 1 rd
6. **Equivalent dose system is measured in SI:**
   1. Coulomb on a kg
   2. Gray
   3. Sievert
7. **Dose of X-ray or gamma radiation, under the influence of which 1 cm^3 of dry air produced 2 billion ion pairs under normal conditions is:**
   1. 1 Gray
   2. 1 Sievert
   3. 1 Roentgen
   4. 1 rd
8. **Quality factor alpha radiation is**:
   1. 20
   2. 10
   3. 1
   4. 3
9. **Place the types of ionizing radiation in order of effectiveness of the biological action**:
   1. thermal neutrons
   2. X-ray and gamma-radiation
   3. alpha radiation
   4. protons
10. **Coefficient equal to the radiation risk of ovarian**:
   1. 0.15
   2. 0.25
   3. 0.12
   4. 0.03

Contents: