

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION

**Federal State Autonomous Educational Institution of Higher Education  
«National Research Lobachevsky State University of Nizhny Novgorod»**

Институт клинической медицины

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УТВЕРЖДЕНО  
решением Ученого совета ННГУ  
протокол № 10 от 02.12.2024 г.

**Working programme of the discipline**

Physics, medical physics

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Higher education level

Specialist degree

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Area of study / speciality

31.05.01 - General Medicine

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Focus /specialization of the study programme

General Medicine

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Mode of study

full-time

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Nizhny Novgorod

Year of commencement of studies 2025

## 1. Место дисциплины в структуре ОПОП

Дисциплина Б1.О.11 Физика, медицинская физика относится к обязательной части образовательной программы.

## 2. Планируемые результаты обучения по дисциплине, соотнесенные с планируемыми результатами освоения образовательной программы (компетенциями и индикаторами достижения компетенций)

Формируемые компетенции (код, содержание компетенции)	Планируемые результаты обучения по дисциплине (модулю), в соответствии с индикатором достижения компетенции		Наименование оценочного средства	
	Индикатор достижения компетенции (код, содержание индикатора)	Результаты обучения по дисциплине	Для текущего контроля успеваемости	Для промежуточной аттестации
ОПК-10: Способен понимать принципы работы современных информационных технологий и использовать их для решения задач профессиональной деятельности	ОПК-10.1: составляет и планирует решение стандартных профессиональных задач ОПК-10.2: использует информационные, библиографические ресурсы, медико-биологическую терминологию, информационно-коммуникационные технологии ОПК-10.3: знает и учитывает основные требования информационной безопасности	ОПК-10.1: to know the theoretical foundations of medical informatics; methods of collecting, storing, searching, processing, converting and distributing information in medical information systems; types, structure, characteristics and basic principles of building medical information systems; principles of automation and management of healthcare institutions using modern computer technologies; basic requirements of information security; be able to analyze, text and graphic processing of medical data using standard software tools, as well as applied and special software tools; determine the functionality of medical information systems; use modern information and information and communication technologies to solve professional tasks; possess basic information transformation technologies - text, tabular editors, Internet search; basic methods of statistical processing of clinical and experimental data using standard applied and special software tools; terminology related to modern information and telecommunication	Допуск к лабораторной работе Отчет по лабораторным работам Контрольная работа Тест	Экзамен: Контрольные вопросы Задачи

		<p><i>technologies in relation to solving medical and healthcare problems; basic skills in using medical information systems and Internet resources to solve professional tasks, taking into account the basic requirements of information security.</i></p> <p><i>OIIK-10.2: be able to analyze, text, and graphically process medical data using standard software tools, as well as applied and special software tools; determine the functionality of medical information systems; to use modern information and communication technologies to solve the tasks of professional activity</i></p> <p><i>OIIK-10.3: possess basic</i></p> <p><i>information transformation technologies - text, tabular editors, Internet search; basic methods of statistical processing of clinical and experimental data using standard applied and special software tools; terminology related to modern information and telecommunication technologies in relation to solving medical and healthcare problems; basic skills in using medical information systems and Internet resources to solve professional problems, taking</i></p>		
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		into account the basic requirements information security.		
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### 3. Структура и содержание дисциплины

#### 3.1 Трудоемкость дисциплины

	<b>очная</b>
<b>Общая трудоемкость, з.е.</b>	<b>4</b>
<b>Часов по учебному плану</b>	<b>144</b>
в том числе	
<b>аудиторные занятия (контактная работа):</b>	
- занятия лекционного типа	<b>42</b>
- занятия семинарского типа (практические занятия / лабораторные работы)	<b>42</b>
- КСР	<b>2</b>
<b>самостоятельная работа</b>	<b>22</b>
<b>Промежуточная аттестация</b>	<b>36</b> <b>Экзамен</b>

#### 3.2. Содержание дисциплины

(структурированное по темам (разделам) с указанием отведенного на них количества академических часов и виды учебных занятий)

Наименование разделов и тем дисциплины	Всего (часы)	в том числе			
		Контактная работа (работа во взаимодействии с преподавателем), часы из них			Самостоятельная работа обучающегося, часы
		Занятия лекционного типа	Занятия семинарского типа (практические занятия/лабораторные работы), часы	Всего	
о Ф о	о Ф о	о Ф о	о Ф о	о Ф о	
Тема 1: Введение в физику. Кинематика/Topic 1: Introduction to physics. Kinematics	8	2	2	4	4
Тема 2. Механические колебательные и волновые процессы. Акустика/Topic 2: Mechanical vibrational and wave processes. Acoustics.	16	4	8	12	4
Тема 3. Механические свойства биологических тканей/Topic 3. Mechanical properties of biological tissues.	12	6	2	8	4
Тема 4. Основные понятия гидродинамики. Физические принципы гемодинамики/Topic 4. Basic concepts of hydrodynamics. Physical principles of hemodynamics.	12	8	2	10	2
Тема 5. Электрические и магнитные явления в организме/Topic 5.	22	8	10	18	4

Electrical and magnetic phenomena in the body.					
Тема 6. Оптика. Физика атомов и молекул/Topic 6. Optics. Physics of atoms and molecules.	20	8	10	18	2
Тема 7. Ионизирующее излучение, основы дозиметрии/Topic 7. Ionizing radiation, basics of dosimetry.	16	6	8	14	2
Аттестация	36				
КСР	2			2	
Итого	144	42	42	86	22

### Contents of sections and topics of the discipline

Тема 1: Введение в физику. Кинематика/Topic 1: Introduction to physics. Kinematics. Kinematics and dynamics of translational and rotational motion. Basic kinematic equations.

Тема 2. Механические колебательные и волновые процессы. Акустика/Topic 2: Mechanical vibrational and wave processes. Acoustics. Doppler effect.

Тема 3. Механические свойства биологических тканей/Topic 3. Mechanical properties of biological tissues. Hooke's law. Mechanical stress. Young's modulus.

Тема 4. Основные понятия гидродинамики. Физические принципы гемодинамики/Topic 4. Basic concepts of hydrodynamics. Physical principles of hemodynamics. Basic concepts of fluid dynamics. The jet continuity condition. Bernoulli's equation. Poiseuille formula. Newtonian and non-Newtonian fluids. Laminar and turbulent flow. Peculiarities of blood flow through large and small blood vessels. Surface tension in fluids. Capillary phenomena.

Тема 5. Электрические и магнитные явления в организме/Topic 5. Electrical and magnetic phenomena in the body. Basic characteristics of the electric field. Primary mechanisms of action of electrostatic fields. of electrostatic fields on biological objects. Electrical conductivity of biological tissues and fluids for direct current. Alternating current. Different types of electrical resistances in an AC circuit. Impedance. Basic characteristics of a magnetic field. Magnetic properties of biological tissues. Primary mechanisms of impact of magnetic fields on the organism. Therapeutic use of magnetic fields. Electrostimulation of tissues and organs. Parameters of impulse signal and their physiological meaning. physiological value. Effects of high frequency currents and fields on the body.

Тема 6. Оптика. Физика атомов и молекул/Topic 6. Optics. Physics of atoms and molecules. Electromagnetic waves, electromagnetic wave scale. Interference and diffraction Interference and diffraction of light. Polarization of light. Energy emission and absorption by atoms. Structure of energy levels of atoms and molecules. Optical spectra of atoms and complex molecules. Medical applications of Luminescent methods of research, photolorimetry and spectrophotometry. Light scattering. Nephelometry. Optical quantum generators (lasers). Characteristics of laser radiation. Physical basis of laser therapy and surgery. Electron paramagnetic resonance (EPR), nuclear magnetic resonance (NMR) and Magnetic resonance imaging (MRI). Principles and diagnostic capabilities.

Тема 7. Ионизирующее излучение, основы дозиметрии/Topic 7. Ionizing radiation, basics of dosimetry. X-ray radiation, its nature. Interaction of x-ray radiation with matter. Physical principles of X-ray diagnosis and X-ray therapy. The concept of X-ray computed tomography. Basic characteristics of atomic nuclei. Radioactive decay. Interaction of ionizing radiation with matter. Physical basis of radionuclide methods of Diagnostics and radiation therapy. Dosimetry of ionising radiation.

#### 4. Учебно-методическое обеспечение самостоятельной работы обучающихся

Самостоятельная работа обучающихся включает в себя подготовку к контрольным вопросам и заданиям для текущего контроля и промежуточной аттестации по итогам освоения дисциплины приведенным в п. 5.

Для обеспечения самостоятельной работы обучающихся используются:  
Электронные курсы, созданные в системе электронного обучения ННГУ:

Physics, medical physics, <https://e-learning.unn.ru/course/view.php?id=2298>.

Иные учебно-методические материалы:

Ремизов А.Н. Медицинская и биологическая физика : учебник / Ремизов А.Н. - Москва : ГЭОТАР-Медиа, 2023. - 656 с. - ISBN 978-5-9704-7498-3.

<https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=839386&idb=0>

## **5. Assessment tools for ongoing monitoring of learning progress and interim certification in the discipline (module)**

### **5.1 Model assignments required for assessment of learning outcomes during the ongoing monitoring of learning progress with the criteria for their assessment:**

#### **5.1.1 Model assignments (assessment tool - Admission to laboratory work) to assess the development of the competency ОПК-10:**

Admission to the laboratory work "Study of harmonic oscillations using the example of small oscillations of a mathematical pendulum".\*

1. What are free undamped harmonic oscillations, what equation is it described by
2. Explain the difference between forced oscillations, self-oscillations and parametric oscillations Give examples.
3. What is natural frequency of oscillations, what does it depend on
4. What is a non-harmonic oscillation
5. What is an oscillation spectrum
6. What is a mathematical pendulum? What does the period of oscillation of a mathematical pendulum depend on

Admission to the laboratory work "Basic concepts of geometrical optics. Determination of the refractive index of optical materials".\*\*

1. What is the refractometry method based on
2. What is the definition of relative and absolute refractive index
3. What is total internal reflection? Explain the concept of the limiting angle of reflection.

4. How does the refractive index depend on the concentration of the solution

5. Explain the optical scheme of an Abbe refractometer.

Admission to the laboratory work "Basic concepts of geometrical optics. The eye as an optical system".\*\*\*

1. Describe the structure of the eye in terms of optics.

2. What is accommodation

3. What visual defects are you know about? How can they be corrected

4. A person is used to reading a book at a distance of 45 cm from his eyes. What should be the optical power of glasses that a person has to wear in order to read a book holding it at a distance of best vision  $d_0 = 25$  cm

5. A nearsighted person can read a book at a distance of no more than 15 cm from his eyes. What is the power of the eyeglasses that a person must wear in order to read a book at a distance of best vision  $d_0 = 25$  cm

Admission to the laboratory work "Physical basis of ultrasound in medicine. The Doppler effect for ultrasonic waves".\*\*

1. List the characteristics of ultrasonic waves.

2) What does the absorption and reflection of ultrasound depend on

3. In what areas of medicine are ultrasonic waves used? What is the basis of their application

4. What is the Doppler effect? Give the formula for the Doppler frequency shift.

Admission to the laboratory work "Generators of electromagnetic oscillations in medicine. Study of damped electromagnetic oscillations in a closed oscillating circuit"\*\*\*.

1. Which target is called an oscillating circuit

2. What energy transformations take place in an oscillating circuit

3. What causes the damping of oscillations

4. What does the attenuation coefficient show

5. What is the logarithmic decrement of damping

6. Specify the fields of application of electromagnetic oscillation generators in medicine.

Admission to the laboratory work "Therapeutic application of electric current. Therapeutic electrophoresis and galvanization".\*\*

1. Define galvanization
2. State the therapeutic effects of galvanisation.
3. Explain the reasons for the reduction of pain syndrome with galvanisation.
4. What is electrophoresis? Describe the benefits of electrophoresis.
5. Name several therapeutic effects following electrophoresis.

Questions

1. Introduction to physics. Kinematics. Kinematics and dynamics of translational and rotational motion. Basic kinematic equations.\*\*
2. Mechanical vibrational and wave processes. Acoustics. Doppler effect.\*
3. Mechanical properties of biological tissues. Hooke's law. Mechanical stress. Young's modulus.\*\*
4. Basic concepts of hydrodynamics. Physical principles of hemodynamics. Basic concepts of fluid dynamics. The jet continuity condition. Bernoulli's equation. Poiseuille formula.\*\* Newtonian and non-Newtonian fluids. Laminar and turbulent flow. Peculiarities of blood flow through large and small blood vessels. Surface tension in fluids. Capillary phenomena.\*
5. Electrical and magnetic phenomena in the body. Basic characteristics of the electric field. Primary mechanisms of action of electrostatic fields. of electrostatic fields on biological objects.\* Electrical conductivity of biological tissues and fluids for direct current. Alternating current. Different types of electrical resistances in an AC circuit. Impedance. Basic characteristics of a magnetic field.
6. Magnetic properties of biological tissues. Primary mechanisms of impact of magnetic fields on the organism. Therapeutic use of magnetic fields. Electrostimulation of tissues and organs. Parameters of impulse signal and their physiological meaning. physiological value. Effects of high frequency currents and fields on the body. \*\*
7. Optics. Physics of atoms and molecules. Electromagnetic waves, electromagnetic wave scale. Interference and diffraction Interference and diffraction of light. Polarization of light. Energy emission and absorption by atoms. Structure of energy levels of atoms and molecules. Optical spectra of atoms and complex molecules. Medical applications of Luminescent methods of research, photolorimetry and spectrophotometry. Light scattering. Nephelometry. Optical quantum generators (lasers). Characteristics of laser radiation.
8. Physical basis of laser therapy and surgery. Electron paramagnetic resonance (EPR), nuclear magnetic resonance (NMR) and Magnetic resonance imaging (MRI). Principles and diagnostic capabilities.\*\*
9. Ionizing radiation, basics of dosimetry. X-ray radiation, its nature. Interaction of x-ray radiation with matter. Physical principles of X-ray diagnosis and X-ray therapy. The concept of X-ray computed tomography. Basic characteristics of atomic nuclei. Radioactive decay. Interaction of ionizing radiation with matter. Physical basis of radionuclide methods of Diagnostics and radiation therapy. Dosimetry of ionising radiation.\*\*\*

**Assessment criteria (assessment tool — Admission to laboratory work)**

Grade	Assessment criteria
pass	The level of knowledge in the volume corresponding to the training program. Several mistakes were made a brief overview / Level of knowledge corresponds to the training program. There are a few minor errors.
fail	The level of knowledge is below the minimum requirements. There were gross mistakes /The level of knowledge is below the minimum requirements.

### 5.1.2 Model assignments (assessment tool - Report on laboratory works) to assess the development of the competency ОПК-10:

- 1 Determine the acceleration of the gravity from a graph of the period of a mathematical pendulum versus the length of a string. \*
2. Using a set of collecting and scattering lenses, construct a model of a healthy eye. Show on the model how accommodation is performed. Explain how the eye works in terms of geometrical optics. \*
- 3 Describe the major visual defects (nearsightedness and farsightedness) in terms of geometrical optics. Show how vision can be corrected using lenses.\*
4. Determine the salt content of a solution from the known dependence of the index of refraction of light on the concentration of the solution.\*
5. Derive a formula for determining the velocity of an erythrocyte if the ultrasound frequency to be used and the Doppler shift in frequencies are known, assuming that the device is stationary on the body surface and the cell is moving towards it.\*
6. Determine the electrophoretic mobility of manganese oxide ions in a salt solution using a Potok-1 medical galvanisation apparatus. \*\*
7. Determine the logarithmic decrement of damping, quality factor and critical resistance of a closed oscillating circuit consisting of a capacitor with a capacity of  $5.7 \mu\text{F}$ , a solenoid with an inductance of  $39 \text{ mH}$  and an active resistance of  $10 \text{ Ohm}$ .\*

### Assessment criteria (assessment tool — Report on laboratory works)

Grade	Assessment criteria
pass	Отчет оформлен в печатном виде в форме единого документа или письменно в отдельной тетради. В отчете приведены: название работы, ее цель, используемое оборудование и материалы, изложен ход работы. По результатам выполнения каждого задания лабораторной работы сделан краткий вывод. Отчет включает рисунки с графиками, оформленными в печатном виде или на бумаге-миллиметровке, таблицы с результатами измерений. Подписи и разъяснения к иллюстрациям и таблицам подробные и понятные. Отчеты, включающие вычисления, содержат и формулы, и сам расчет требуемых физических величин, выполненный с использованием собственных результатов измерений. Вывод по всей лабораторной работе развернутый и содержит объяснение полученных результатов / The report is made out in printed

Grade	Assessment criteria
	<p>form (in the form of a single document) or the report is written in a separate notebook. The report contains the name of the work, its purpose, the equipment and materials used, and also describes the sequence of laboratory work. According to the results of each task of the laboratory work a brief conclusion is made. The report includes figures with graphs and tables with the results of measurements. Captions and explanations of illustrations and tables are detailed and clear. Reports that include calculations contain both formulas and the calculation of the required physical quantities. The conclusion of the whole laboratory work is detailed and contains an explanation of the results obtained.</p>
fail	<p>В отчете не приведена цель. Отчет не содержит выводов по результатам выполнения каждого задания. В отчет не включены необходимые рисунки с графиками или они оформлены с грубым нарушением требований: нарисованы от руки с несоблюдением масштаба; не содержат подписей. Отчеты не содержат общего вывода по всей лабораторной работе или приведен вывод, который не соответствует цели лабораторной работы / The purpose of the laboratory work is not given in the report. The report does not contain conclusions on the results of each task. The report does not include the necessary drawings with graphs or they are designed with a gross violation of the requirements: hand-drawn with failure to observe the scale; graphs do not contain signatures. The report does not contain a general conclusion on the whole laboratory work or the conclusion is given, which does not correspond to the purpose of the laboratory work.</p>

### 5.1.3 Model assignments (assessment tool - Control work) to assess the development of the competency ОПК-10:

1. What is progressive motion?\*
2. What is normal and tangential acceleration?\*
3. What are the relationships between the linear and angular characteristics of curvilinear motion?\*
4. Differential equation of free, damped and forced oscillations. The condition of resonance.\*
5. What is the Doppler effect? How to determine the speed of a moving object from the known Doppler shift?\*
6. How is the intensity level of sound determined? What does the perception of sound depend on?\*\*\*
7. On what does the optical power of lenses depend? \*
8. How is the relative index of refraction of light determined when moving from one medium to another?\*
9. What is the optical path length?\*
10. How to determine the binding energy of the nucleus of an atom?\*
11. How does the activity of an unstable chemical element depend on time?\*\*\*
12. What are absorbed dose and equivalent dose?\*

### Assessment criteria (assessment tool — Control work)

Grade	Assessment criteria
pass	Уровень знаний в объеме, соответствующем программе подготовки. Допущено несколько негрубых ошибок / The level of knowledge is in agreement with the training programme. There are a few minor errors
fail	Уровень знаний ниже минимальных требований. Имели место грубые ошибки /The level of knowledge is below the minimum requirements. There were gross errors

#### 5.1.4 Model assignments (assessment tool - Test) to assess the development of the competency ОПК-10:

1. Oscillations, during which the oscillating system is exposed to an external periodically changing force, are called\*

a) **Forced vibrations.**

b) Harmonic vibrations.

c) Natural vibrations.

d) Parametric vibrations.

e) Self-oscillations.

2. The hearing threshold is\*\*

a) the maximum intensity of sound distinguishable by the human ear.

b) **the sound level below which a person's ear is unable to detect any sound.**

c) the lowest frequency of sound at which an auditory sensation is produced.

d) the greatest frequency of sound at which an auditory sensation is produced.

3. If an object of investigation emitting ultrasound moves towards the ultrasound transducer, the measured frequency will be\*

a) less than the original frequency of the ultrasound.

b) **greater than the original frequency of the ultrasound.**

c) equal to the original ultrasound frequency.

d) inversely proportional to the speed of the ultrasound transducer.

4. Snell's law of refraction states that .... \*

- a) the refracted ray does not lie in the same plane as the incident ray.
- b) the refracted ray lies in the same plane as the incident ray and the normal to the interface between the two media, the ratio of the cosines of the angle of incidence and the angle of refraction being constant for a given pair of media.
- c) the refracted ray lies in the same plane as the incident ray and the normal to the interface between the two media, and the ratio of the sines of the angle of incidence and the angle of refraction is a constant value for a given pair of media.**
- d) the refracted ray lies in the same plane as the incident ray and the normal to the interface between the two media, and the ratio of the sine of the angle of incidence to the cosine of the angle of refraction is a constant value for a given pair of media.

5. The relative refractive index of two media indicates \*\*

- a) how many times the speed of light in the medium is greater than the speed of light in a vacuum;
- b) how many times the speed of light changes when light passes from the first medium to the second medium;**
- c) the refractive index of the substance in relation to the "vacuum";
- d) how many times the density of one medium is greater than the density of the other medium.

6. The following tissues of the body are classified as dielectrics: \*

- a) Tissues that do not conduct electrical current, for example: connective tissue, tendon, bone without periosteum, dry skin.**
- b) Tissues that conduct electric current, for example: blood, lymph.
- c) Muscles, tendons, nerves, conductive tissues.
- d) The upper layer of the heart muscle.

7. What particles make up the nucleus of an atom?\*

- a) Protons and electrons.
- b) Protons and neutrons.**
- c) Neutrons and electrons.
- d) Protons, neutrons and electrons.

8. Arrange the different types of electromagnetic waves in ascending order of their wavelengths:\*\*

- a) Gamma radiation, X-rays, ultraviolet radiation, visible radiation, infrared radiation.**
- b) Radio wave radiation, infrared radiation, gamma radiation, x-ray radiation.

- c) X-ray radiation, microwave radiation, infrared radiation, gamma radiation, alpha radiation.  
 d) Infrared radiation, visible radiation, ultraviolet radiation, X-ray radiation, gamma radiation.

9. The half-life is\*

- a) A period of time during which the average number of nuclei that have not decayed is halved.**  
 b) a period of time during which the volume of an irradiated object is halved.  
 c) half the time interval during which all nuclei decay.  
 d) the period of time during which the mass of the irradiated object is halved.

10. Radioactivity is defined as \*

- a) The spontaneous decay of unstable nuclei with the emission of other nuclei or elementary particles.**  
 b) The ability of biological tissue to emit electromagnetic radiation in the radio range.  
 c) Spontaneous fusion of unstable nuclei to form other nuclei or elementary particles.  
 d) Spontaneous disintegration of atoms to emit ultraviolet or X-ray radiation.

**Assessment criteria (assessment tool — Test)**

Grade	Assessment criteria
pass	Уровень знаний в объеме, соответствующем программе подготовки. Допущено несколько негрубых ошибок / The level of knowledge is in agreement with the training programme. There are a few minor errors
fail	Уровень знаний ниже минимальных требований. Имели место грубые ошибки /The level of knowledge is below the minimum requirements. There were gross errors

**5.2. Description of scales for assessing learning outcomes in the discipline during interim certification**

**Шкала оценивания сформированности компетенций**

Уровень сформированности компетенций (индикатора достижения компетенций)	плохо	неудовлетворительно	удовлетворительно	хорошо	очень хорошо	отлично	превосходно
	не зачтено			зачтено			

<u>Знания</u>	Отсутствие знаний теоретического материала. Невозможность оценить полноту знаний вследствие отказа обучающегося от ответа	Уровень знаний ниже минимальных требований. Имели место грубые ошибки	Минимально допустимый уровень знаний. Допущено много негрубых ошибок	Уровень знаний в объеме, соответствующем программе подготовки. Допущено несколько негрубых ошибок	Уровень знаний в объеме, соответствующем программе подготовки. Допущено несколько несущественных ошибок	Уровень знаний в объеме, соответствующем программе подготовки. Ошибок нет.	Уровень знаний в объеме, превышающем программу подготовки.
<u>Умения</u>	Отсутствие минимальных умений. Невозможность оценить наличие умений вследствие отказа обучающегося от ответа	При решении стандартных задач не продемонстрированы основные умения. Имели место грубые ошибки	Продемонстрированы основные умения. Решены типовые задачи с негрубыми ошибками. Выполнены все задания, но не в полном объеме	Продемонстрированы все основные умения. Решены все основные задачи с негрубыми ошибками. Выполнены все задания в полном объеме, но некоторые с недочетами	Продемонстрированы все основные умения. Решены все основные задачи. Выполнены все задания в полном объеме, но некоторые с недочетами	Продемонстрированы все основные умения. Решены все основные задачи с отдельными несущественными недочетами, выполнены все задания в полном объеме	Продемонстрированы все основные умения. Решены все основные задачи. Выполнены все задания, в полном объеме без недочетов
<u>Навыки</u>	Отсутствие базовых навыков. Невозможность оценить наличие навыков вследствие отказа обучающегося от ответа	При решении стандартных задач не продемонстрированы базовые навыки. Имели место грубые ошибки	Имеется минимальный набор навыков для решения стандартных задач с некоторыми недочетами	Продемонстрированы базовые навыки при решении стандартных задач с некоторыми недочетами	Продемонстрированы базовые навыки при решении стандартных задач без ошибок и недочетов	Продемонстрированы навыки при решении нестандартных задач без ошибок и недочетов	Продемонстрирован творческий подход к решению нестандартных задач

### Scale of assessment for interim certification

Grade		Assessment criteria
pass	<b>outstanding</b>	All the competencies (parts of competencies) to be developed within the discipline have been developed at a level no lower than "outstanding", the knowledge and skills for the relevant competencies have been demonstrated at a level higher than the one set out in the programme.
	<b>excellent</b>	All the competencies (parts of competencies) to be developed within the discipline have been developed at a level no lower than "excellent",
	<b>very good</b>	All the competencies (parts of competencies) to be developed within the discipline have been developed at a level no lower than "very good",
	<b>good</b>	All the competencies (parts of competencies) to be developed within the discipline have been developed at a level no lower than "good",
	<b>satisfactory</b>	All the competencies (parts of competencies) to be developed within the discipline have been developed at a level no lower than "satisfactory", with at least one competency

		developed at the "satisfactory" level.
<b>fail</b>	<b>unsatisfactory</b>	At least one competency has been developed at the "unsatisfactory" level.
	<b>poor</b>	At least one competency has been developed at the "poor" level.

### **5.3 Model control assignments or other materials required to assess learning outcomes during the interim certification with the criteria for their assessment:**

#### **5.3.1 Model assignments (assessment tool - Control questions) to assess the development of the competency ОПК-10**

1. Kinematics and dynamics of translational and rotational motion. Basic kinematic equations.\*
2. Mechanical vibrational and wave processes. Acoustics. Doppler effect.\*
3. Mechanical properties of biological tissues. Hooke's law. Mechanical stress. Young's modulus.\*\*
4. Basic concepts of fluid dynamics. The jet continuity condition. Bernoulli's equation. Poiseuille formula.\*
5. Newtonian and non-Newtonian fluids.\*
6. Laminar and turbulent flow. Peculiarities of blood flow through large and small blood vessels. Surface tension in fluids. Capillary phenomena.\*
7. Basic characteristics of the electric field. Primary mechanisms of action of electrostatic fields. of electrostatic fields on biological objects.\*\*
8. Electrical conductivity of biological tissues and fluids for direct current. Alternating current. Different types of electrical resistances in an AC circuit. Impedance.
9. Basic characteristics of a magnetic field.
10. Magnetic properties of biological tissues. Primary mechanisms of impact of magnetic fields on the organism. Therapeutic use of magnetic fields.
11. Electrostimulation of tissues and organs. Parameters of impulse signal and their physiological meaning. physiological value. Effects of high frequency currents and fields on the body.
12. Electromagnetic waves, electromagnetic wave scale. Interference and diffraction Interference and diffraction of light. Polarization of light.
13. Energy emission and absorption by atoms. Structure of energy levels of atoms and molecules. Optical spectra of atoms and complex molecules. Medical applications of Luminescent methods of research, photocalorimetry and spectrophotometry.
14. Light scattering. Nephelometry. Optical quantum generators (lasers). Characteristics of laser radiation. Physical basis of laser therapy and surgery.
15. Electron paramagnetic resonance (EPR), nuclear magnetic resonance (NMR) and Magnetic resonance imaging (MRI). Principles and diagnostic capabilities.
16. X-ray radiation, its nature. Interaction of x-ray radiation with matter. Physical principles of X-ray diagnosis and X-ray therapy. The concept of X-ray computed tomography.
17. Basic characteristics of atomic nuclei. Radioactive decay. Interaction of ionizing radiation with matter. Physical basis of radionuclide methods of Diagnostics and radiation therapy. Dosimetry of ionising radiation.

### Assessment criteria (assessment tool — Control questions)

Grade	Assessment criteria
outstanding	All competences (parts of competences) are formed at the level of at least 'perfect'. Demonstrated knowledge, skills and mastery of the relevant competences at a level higher than that provided by the programme
excellent	All competences (parts of competences) are formed at the level of at least 'excellent'
very good	All competences (parts of competences) are formed at the level of at least 'very good'
good	All competences (parts of competences) are formed at the level of at least 'good'
satisfactory	All competences (parts of competences) are formed at the level of at least 'satisfactory'. At least one competence is formed at the level of 'satisfactory'
unsatisfactory	At least one competence is formed at the level of "unsatisfactory".
poor	At least one competence is formed at the level of "poor"

### 5.3.2 Model assignments (assessment tool - Tasks) to assess the development of the competency ОПК-10

1. Normal monochromatic light is incident on a diffraction grating. The wavelength of the light is 600 nm. For a diffraction maximum of the 2nd order, the deviation from the original direction is an angle of 30°. Determine the period of the diffraction grating.\*

2. Calculate the binding energy per nucleon of  $^{10}_5\text{B}$ .\*

3. Forced oscillations are described by the differential equation  $0.2x'' + 0.24x' + 1.8x = 0.6 \sin 5t$ . At what frequency of the external force will resonance be observed?\*

4. An ambulance has traveled a distance  $l=20 \text{ km}$ . The first part of its journey the car traveled at a speed 3 times greater than its average speed, and the second part of its journey - at a speed 1.5 times less than the average speed. Find the length of the first part of the journey.\*

5. Construct and characterize an image of an object located between the front focus of a collecting lens and the lens itself. The base of the object is on the optical axis of the optical scheme.\*\*

6. A medical syringe is placed horizontally. The syringe piston is pressed with a force of 0.25 N. The diameter of the piston is 9 mm. The density of the liquid is  $1300 \text{ kg/m}^3$ . At what speed will the liquid flow out of the syringe?\*

7. The logarithmic decrement of attenuation of a tuning fork oscillating at a frequency of 120 Hz is 0.007. After what period of time will the amplitude of the oscillation of the tuning fork decrease by a factor of 60? Consider that the period of damped oscillations is close to the period of free undamped oscillations.\*

8. A stone falls from a height of 259 m with an initial velocity of 2 m/s. How far will the stone travel during the last 2 seconds of its flight?\*\*\*
9. Construct and characterize an image of an object located at a distance equal to twice the focal length of the collecting lens. The base of the object is on the optical axis of the optical scheme.\*\*
10. A driver traveling at a speed of 25 m/s gives a signal with a frequency of 680 Hz. What frequency signal will be heard by the driver of the other car traveling at 15 m/s before and after the cars meet? The speed of sound is 340 m/s.\*
11. The linear attenuation coefficient of concrete is  $10 \text{ m}^{-1}$ . Determine by how many times the intensity of a narrow beam of cobalt  $\gamma$ -rays ( $^{27}\text{Co}60$ ) will decrease when passing through a concrete plate 25 cm thick. Determine the thickness of the half attenuation layer for concrete.\*
12. The drip is located at a height of 37 cm above the patient's bed, a solution of drugs was injected into the forearm vein. The density of the solution is  $1032 \text{ kg/m}^3$ , viscosity is  $1.6 \text{ mPa}\cdot\text{s}$ , the pressure in the vein was 55 mm of water column. The needle inserted into the vein has a lumen diameter of 0.5 mm. Determine the length of the needle to be used to deliver 400 ml of solution through the drip into the patient's venous bed in 40 minutes.\*
13. The motion of a medical helicopter is described by the equation:  $x = 130 + 30t + 1.5t^2$ . Determine the moment of time at which the instantaneous velocity will be equal to 60 m/s.\*
14. The natural absorption index of the substance is  $0.3 \text{ cm}^{-1}$ . A light flux falls on a 2.35 cm thick plate of this substance. Determine what part of the light flux will pass through this plate. The scattering of light in the plate is neglected.\*
15. Determine the half-life of radioactive iron  $^{59}_{26}\text{Fe}$ , if initially there were  $6 \times 10^{18}$  atoms and after 225 days it became  $1.875 \times 10^{17}$ .\*
16. Determine the minimum wavelength in the X-ray spectrum if the velocity of electrons falling on the anti-cathode of an X-ray tube is  $2 \cdot 10^8 \text{ m/s}$ . The mass of the electron is  $9.1 \cdot 10^{-31} \text{ kg}$ ,  $h = 6.63 \cdot 10^{-34} \text{ J}\cdot\text{s}$ .\*
17. In one of the main human arteries the maximum value of Reynolds number is 4175. The vessel lumen diameter is 13 mm, blood density is  $1050 \text{ kg/m}^3$ . Determine the coefficient of dynamic viscosity of blood if the maximum linear velocity of blood flow in the artery is 1.5 m/s.\*
18. The initial activity of  $^{131}\text{I}$  is  $10^3 \text{ Bq}$ . Calculate the number of radioactive nuclei of this substance after 30 days. The half-life is 8 days.\*\*
19. Determine the distance between the electrodes during electrophoresis if the mobility of ions is  $2 \cdot 10^{-7} \text{ m}^2/\text{V}\cdot\text{s}$ , the voltage between the electrodes is 10 V, and the ions have moved 1.5 cm in 15 minutes?\*
20. Determine at what angle light rays fall from the air onto a plane-parallel plate with refractive indices  $n=1.5$ , if the angle of refraction of the rays is  $30^\circ$ . The thickness of the plate is 12.0 mm Prove that the angle at which the light rays leave the plate is equal to the angle of incidence. (Draw a picture).\*
21. When a body falls freely to the ground from a height  $h$ , it has travelled a distance equal to  $h/3$  during the last second of its flight. Determine the height  $h$  from which the body fell.\*

22. An air ambulance is travelling at a speed of 60 m/s before landing. After 15 s its speed has decreased by 2 times. Determine the acceleration of the aeroplane.\*\*
23. The distance of best vision for a farsighted eye is 45 cm. What glasses should I use to bring my vision closer to normal?\*
24. The hydrodynamic resistance of the precapillary section (containing arterioles) is 1.5 times greater than the hydrodynamic resistance of the section of the human bloodstream containing capillaries. Determine how many times the diameter of an arteriole is greater than the diameter of a capillary. The length of an arteriole is 0.8 mm, their total number of arterioles is  $3.5 \cdot 10^8$ , and the length of a capillary is 0.11 mm. The total number of capillaries is  $2 \cdot 10^9$ .\*
25. In the observed erythrocyte sedimentation rate reaction, the erythrocyte moves uniformly at a speed of 3 mm/h. The density of the erythrocyte is  $1085 \text{ kg/m}^3$ , the density of blood plasma is  $1035 \text{ kg/m}^3$ . Considering the erythrocyte to be a ball with a diameter of  $5.7 \text{ }\mu\text{m}$ , determine the viscosity of the blood plasma.\*

### Assessment criteria (assessment tool — Tasks)

Grade	Assessment criteria
outstanding	A creative approach to solving non-standard problems was demonstrated.
excellent	Skills to solve non-standard problems without errors and mistakes were demonstrated.
very good	The ability to solve standardized problems without errors or mistakes was demonstrated.
good	The ability to solve standardized problems with some deficiencies was demonstrated.
satisfactory	There is a minimum skill set for standard tasks with some deficiencies.
unsatisfactory	Basic skills were not demonstrated in solving standard problems. There were gross errors.
poor	Lack of understanding of the material. It is impossible to assess the presence of skills.

### 6. Учебно-методическое и информационное обеспечение дисциплины (модуля)

Основная литература:

1. Remizov A.N. Medical and biological physics : учебник / Remizov A.N. - Москва : ГЭОТАР-Медиа, 2022. - 576 с. - ISBN 978-5-9704-7102-9., <https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=809552&idb=0>.
2. Denisova O. A. Physics. Ч. 1. Sections «Mechanics. Molecular physics. Thermodynamics» / Denisova O. A. - Уфа : УГНТУ, 2022. - 57 с. - Книга из коллекции УГНТУ - Физика. - ISBN 978-5-7831-2183-8., <https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=895091&idb=0>.

3. Denisova O. A. Physics. Ч. 2. Sections «Electricity. Magnetism» / Denisova O. A. - Уфа : УГНТУ, 2022. - 58 с. - Книга из коллекции УГНТУ - Физика. - ISBN 978-5-7831-2184-5., <https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=895090&idb=0>.
4. Denisova O. A. Physics. Ч. 3. Sections «Optics. Atomic physics. Nuclear physics» / Denisova O. A. - Уфа : УГНТУ, 2022. - 49 с. - Книга из коллекции УГНТУ - Физика. - ISBN 978-5-7831-2185-2., <https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=895092&idb=0>.

Дополнительная литература:

1. Васильев А. А. Медицинская и биологическая физика. Лабораторный практикум : учебное пособие / А. А. Васильев. - 2-е изд. ; испр. и доп. - Москва : Юрайт, 2023. - 313 с. - (Высшее образование). - ISBN 978-5-534-05174-2. - Текст : электронный // ЭБС "Юрайт"., <https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=848467&idb=0>.
2. Медицинская физика. Лабораторный практикум. Ч. 1. Медицинская физика. Лабораторный практикум. Часть 1 / Юдинцев А. В., Шерстнева О. Н., Пескова Н. Н., Герасимова С. А. - Нижний Новгород : ННГУ им. Н. И. Лобачевского, 2022. - 54 с. - Рекомендовано методической комиссией Института биологии и биомедицины для студентов ННГУ, обучающихся по специальностям 31.05.01 «Лечебное дело» и 31.05.03 «Стоматология». - Книга из коллекции ННГУ им. Н. И. Лобачевского - Медицина., <https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=830237&idb=0>.
3. Спектрофлуориметрия для количественного определения ионных концентраций : учебно-методическое пособие / А. В. Юдинцев, Н. Ю. Шилягина, В. С. Сухов [и др.] ; ННГУ им. Н. И. Лобачевского. - Нижний Новгород : Изд-во ННГУ, 2015. - 33 с. - Текст : электронный., <https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=850222&idb=0>.
4. Ruchi Shrestha. Ultrasound: A Core Review. - Lippincott Williams & Wilkins, 2018. - 1 online resource. - ISBN 9781496381620. - ISBN 9781496309815. - Текст : электронный., <https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=856464&idb=0>.
5. Eliseeva S. V. Physics, Mathematics: A course of lectures for foreign medical students of the first year : educational book / Eliseeva S. V., Zubkov Y. N. - Ульяновск : УлГУ, 2023. - 392 с. - Книга из коллекции УлГУ - Математика., <https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=930984&idb=0>.
6. Agibova I. M. Personality-oriented teaching of physics: practical course / Agibova I. M., Fedina O. V., Vasilchenko E. A. - Ставрополь : СКФУ, 2022. - 121 с. - Книга из коллекции СКФУ - Психология. Педагогика., <https://e-lib.unn.ru/MegaPro/UserEntry?Action=FindDocs&ids=893696&idb=0>.

Программное обеспечение и Интернет-ресурсы (в соответствии с содержанием дисциплины):

ЭБС «Юрайт». Режим доступа: <http://biblio-online.ru>.

ЭБС «Консультант студента». Режим доступа: <http://www.studentlibrary.ru>.

ЭБС «Лань». Режим доступа: <http://e.lanbook.com/>.

ЭБС «Znanium.com». Режим доступа: [www.znanium.com](http://www.znanium.com).

## **7. Материально-техническое обеспечение дисциплины (модуля)**

Учебные аудитории для проведения учебных занятий, предусмотренных образовательной программой, оснащены мультимедийным оборудованием (проектор, экран), техническими

средствами обучения, компьютерами, специализированным оборудованием: Гальванизатор/ Galvaniser "Поток-1"; Набор приборов для изучения распространения ультразвука / A set of instruments for studying ultrasound propagation; лабораторная установка "модель математического маятника" / laboratory setup "mathematical pendulum model"; лабораторная установка для изучения затухающих электромагнитных колебаний / laboratory setup for studying damped electromagnetic oscillations; рефрактометр / refractometer

Помещения для самостоятельной работы обучающихся оснащены компьютерной техникой с возможностью подключения к сети "Интернет" и обеспечены доступом в электронную информационно-образовательную среду.

Программа составлена в соответствии с требованиями ФГОС ВО по направлению подготовки/специальности 31.05.01 - General Medicine.

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Заведующий кафедрой: Воденеев Владимир Анатольевич, доктор биологических наук.

Программа одобрена на заседании методической комиссии от 28 ноября 2024, протокол № №9.