FGBOU VO "BASHKIR STATE UNIVERSITY"
FACULTY OF MATHEMATICS AND INFORMATION TECHNOLOGIES

APPROVED:

at a meeting of the department
Protocol No. _5_ dated "_12_" January 2022
Head of department

/ Balapanov M.Kh.

AGREED:

Chairman of the Educational and Methodological Commission of the Faculty of Mathematics and Information Technologies

___/Efimov A.M.

**WORKING PROGRAM OF THE DISCIPLINE (MODULE)**

# discipline "Physics"

**obligatory part**

**undergraduate program**

Direction of training **01.03.02 Applied mathematics and informatics**

Training profile **"Applied programming and data analysis"**

Qualification
**Bachelor**

| | |
|---|---|
| Developers | |
| Professor, Doctor of Physical and Mathematical Sciences | / Balapanov M.Kh. |
| Associate Professor, Ph.D. | / Girfanova F.M. |
| Associate Professor, Ph.D. | / Gafurov I.G. |
| Associate Professor, Ph.D. | / Zamanova G.I. |
| Assistant | / Akhmetgaliev B.M. |

For admission: 2022

Ufa 2022

Compiler / compilers:
Balapanov M.Kh., Girfanova F.M., Gafurov I.G., Zamanova G.I., Akhmetgaliev B.M.

The work program of the discipline was approved at a meeting of the Department of General Physics, protocol No. _5_ dated January 12, 2022.

Head of department  _ / Balapanov M.Kh

**List of documents and materials**

## 1. The list of planned learning outcomes in the discipline, correlated with the indicators of achievement of competencies established in the educational program

Based on the results of mastering the discipline, the student must achieve the following learning outcomes:

| Category (group) of competencies | Competence being formed (with code) | Code and name of the indicator of achievement of competence | Learning outcomes by discipline |
|---|---|---|---|
| | GPC-3-3. Ability to apply and modify mathematical models to solve problems in the field of professional activity | GPC-3.1. Know how to develop, analyze and implement new mathematical models to solve problems in the field of professional activity | Know how to develop, analyze and implement new mathematical models to solve problems in the field of professional activity |
| | | GPC-3.2. Be able to develop, analyze and implement new mathematical models for solving problems in the field of professional activity | Be able to develop, analyze and implement new mathematical models for solving problems in the field of professional activity |
| | | GPC-3.3. Have the ability to develop, analyze and implement new mathematical models for solving problems in the field of professional activity | Have the ability to develop, analyze and implement new mathematical models for solving problems in the field of professional activity |

## 2. The purpose and place of discipline in the structure of the educational program

The discipline "Physics" refers to the mandatory part. The discipline is studied in the 4th year in the 7th semester). The goals of studying the discipline: it consists in presenting physics as a single science based on fundamental laws that generalize many experimental facts The task of the discipline is the formation of knowledge, fundamental concepts of physical processes, the formation of skills to apply this knowledge in practice. Ensuring students understand the relationship between physical principles and the features of their practical application. To master the discipline "Physics", the knowledge, skills and activities formed in the process of studying the subjects "Physics" at the previous level of education, as well as the disciplines mastered in the framework of the bachelor's degree are used: "Theoretical Mechanics", "Mathematical Analysis", "Differential Equations", "Theory of Probability", "Fundamentals of Mathematical Statistics", "Workshop on a Computer".

## 3. The content of the work program (volume of discipline, types and types of training sessions, educational and methodological support for independent work of students)

The content of the work program is presented in Appendix No. 1.

## 4. Fund of evaluation materials by discipline

### *4.1. A list of indicators of achievement of competencies indicating the planned learning outcomes for the discipline (module), correlated with the indicators of achievement of competencies established in the educational program. Description of indicators and criteria for evaluating learning outcomes by discipline (module), description of assessment scales*

Code and definition of competence
**GPC-3:** Able to apply and modify mathematical models to solve problems in the field of professional activity

| **Code and name of the indicator of achievement of competence** | **Learning outcomes by discipline** | Criteria for learning outcomes evaluating | | | |
|---|---|---|---|---|---|
| | | 2 ("Not Satisfactory") | 3 ("Satisfactory") | 4 («Good») | 5 («Excellent») |
| GPC-3.1. Know how to develop, analyze and implement new mathematical models to solve problems in the field of professional activity | Know how to develop, analyze and implement new mathematical models to solve problems in the field of professional activity | Shows complete ignorance of the material or has fragmentary knowledge of a small part of the material, makes gross errors | It has significant gaps in knowledge, makes significant errors in the answers | Knows almost everything, allows minor errors in the answers | Knows everything |
| GPC-3.2. Be able to develop, analyze and implement new mathematical models for solving problems in the field of professional activity | Be able to develop, analyze and implement new mathematical models for solving problems in the field of professional activity | Can not | Able, but makes significant mistakes | Able, make minor mistakes | Able perfectly |
| GPC-3.3. Have the ability to develop, analyze and implement new mathematical models for solving problems in the field of professional activity | Have the ability to develop, analyze and implement new mathematical models for solving problems in the field of professional activity | Virtually no owns | Poor, makes big mistakes | Owns, makes minor mistakes | Owns perfection |

### *4.2. Typical control tasks or other materials necessary for evaluating learning outcomes in a discipline (module) correlated with the indicators of achievement of competencies established in the educational program. Methodological materials that determine the procedures for evaluating the results of training in the discipline (module)*

| **Code and name of the indicator of achievement of competence** | **Learning outcomes by discipline** | **Controlled actions to test knowledge, skills and possessions (Assessment tools)** |
|---|---|---|
| | | Testing №1 in error theory, №2 in mechanics, №3 in molecular physics, №4 in electricity and magnetism, №5 in optics, №6 in atomic and nuclear physics. Laboratory work (in the laboratories of mechanics, electricity, optics, atomic physics). Exam. |
| GPC-3.1. Know how to develop, analyze and implement new mathematical models to solve problems in the field of professional activity | Know how to develop, analyze and implement new mathematical models to solve problems in the field of professional activity | |
| GPC-3.2. Be able to develop, analyze and implement new mathematical models for solving problems in the field of professional activity | Be able to develop, analyze and implement new mathematical models for solving problems in the field of professional activity | |

The evaluation criteria for the module-rating system are the points that are set by the teacher for the types of activities (assessment tools) based on the results of studying the modules (sections of the discipline) listed in the rating plan of the discipline (for the exam: current control - a maximum of 40 points; midterm control - a maximum 30 points, reward points - maximum 10). Evaluation scales: (for exam: from 45 to 59 points - "satisfactory"; from 60 to 79 points - "good"; from 80 points - "excellent".

## Rating-plan of the discipline

Физика

name of the discipline according to the working curriculum

direction/specialty: **01.03.02 Applied mathematics and informatics**

course 4, semester 7

| **Types of educational activities of students** | Point for a specific task | Number of assignments per semester | Points | |
|---|---|---|---|---|
| | | | minimal | maximum |
| **Module 1.** Mechanics. Molecular physics and thermodynamics. | | | **0** | **20** |
| **current control** | | | | |
| 1. Accounting for the rating for laboratory work in mechanics and molecular physics | 0-5 | 2 | 0 | 10 |
| **Frontier control** | | | | |
| 3. Test №1 | 10 | 1 | 0 | 10 |
| **Модуль 2.** Электричество и магнетизм. Оптика. Атомная и ядерная физика | | | **0** | **50** |
| **current control** | | | | |
| 1. Accounting for the rating for laboratory work in electricity and magnetism, in optics | 0-5 | 6 | 0 | 30 |
| **Frontier control** | | | | |
| 2. Test № 2 in electricity and optics. | 15 | 1 | 0 | 15 |
| 3. Test № 3 in quantum physics | 5 | 1 | 0 | 5 |
| **Reward points** | | | | |
| 1. Student Olympiad | 0-10 | 1 | **0** | **10** |
| **Attendance (points are deducted from the total points scored)** | | | | |
| 1. Attending lectures | | | **0** | **–6** |
| 2. Attending practical (seminar, laboratory classes) | | | **0** | **–10** |
| **Final control** | | | | |
| exam | **0-15** | **2** | **0** | **30** |

## Exam tickets

**Exam ticket structure:**

The exam consists of two theoretical questions (the first question – in module 1, the second question – in module 2), to which the student must give a written detailed answer.

## Sample questions for the exam:

***Mechanics***

1. Newton's laws. General form of Newton's second law.
2. Energy. Types of energy. Job. Power. Law of energy conservation.
3. Moment of inertia. Moment of power. The basic equation of the dynamics of rotational motion.

4. Angular moment. Equation of moments. Law of conservation of angular momentum.

5. Doppler effect.

6. The principle of relativity in mechanics. Galilean transformations. Lorentz transformations. The law of addition of speeds. Postulates of the special theory of relativity.

### *Molecular physics and thermodynamics*

***1.*** Molecular-kinetic theory of gases. The basic equation of the molecular-kinetic theory of gases.

***2.*** Maxwell distribution. Boltzmann distribution.

***3.*** The first law of thermodynamics. Internal energy and heat capacities of an ideal gas.

***4.*** Adiabatic process. polytropic process.

***5.*** Work performed by an ideal gas in various processes.

***6.*** The second law of thermodynamics. Entropy. Various wording. Nernst's theorem.

***7.*** Carnot cycle. Efficiency.

***8.*** Real gases. Van der Waals equation.

### *Electricity and magnetism*

1..Coulomb's law. Electric field strength. The principle of superposition. Electric field intensity flow. Gauss's theorem and its applications.

2. The work of the electric field. Voltage. Potential. potential gradient. Circulation of an electrostatic field.

3. Conductors in a constant electric field. Electrical capacity. Capacitors.

4. Electric dipole. dipole moment. Dielectrics.

5. Direct current. Ohm's law. Conductivity. Joule heat. Work of electric current

6. Interaction of moving charges. Lorentz force. Ampere power. Magnetic moment in an external field. types of magnets.

7. Magnetic field of a moving charge. Law of Bio-Savart.

8. Magnetic flux. Gauss's theorem for a magnetic field. The law of electromagnetic induction. Inductance. Toki Fuko.

9. Alternating current. Laws of sinusoidal alternating current. AC work.

10. Electromagnetic waves.

### *Оптика*

1. Light as an electromagnetic wave. wave equation. 2. Light vector. The speed of light in a medium and in a vacuum. The absolute refractive index and its relation to the dielectric constant of the medium. Energy flux density. Light intensity. 3. Interference of light. The concept of the coherence of light waves. Methods for observing light interference General scheme of light interference. The condition of interference maxima and minima four. . Interference in thin films (from a plate of constant and variable thickness). Newton's rings. 5. Diffraction of light. Huygens principle. Huygens-Fresnel principle. 6. Diffraction of light in divergent beams Fresnel zone method. 7. Fresnel diffraction by a round hole and by a round opaque disk. 8. Diffraction of light in parallel beams Diffraction of light by a single slit. Diffraction pattern, conditions of maxima and minima. 9. Diffraction grating, its parameters. conditions for highs and lows. Decomposition of white light by a diffraction grating. Angular and linear dispersion, resolution of a diffraction grating. 10. X-ray diffraction on a crystal lattice. 11. Polarization of light. Natural and polarized light. The degree of polarization. Malus' law. 12. Polarization during reflection and refraction. Brewster's corner. 13. Polarization at birefringence. Polaroids and polarizing prisms. 14. Artificial optical anisotropy. Rotation of the plane of polarization. 15. Interaction of light with matter. dispersion of light. Normal and anomalous dispersions. 16. Light absorption. Booger's law. absorption coefficient. 17. Scattering of light. Rayleigh formula

***Квантовая физика***

1. Fundamentals of quantum optics. Thermal equilibrium radiation. Completely black body. Laws of Kirchhoff, Stefan-Boltzmann, Wien. Rayleigh-Jeans formula. Planck formula. 2. Photoelectric effect. Laws of the external photoelectric effect Contradictions between the photoelectric effect and classical physics. Low-frequency boundary of the photoelectric effect. Einstein's equation. Application of the photoelectric effect in practice. 3. Photon and its characteristics. Light pressure. Compton effect. 4. Spectrum of the hydrogen atom. Spectral series. Generalized Balmer formula. 5. Rutherford's model of the atom. 6. Bohr's postulates. Bohr's theory of the hydrogen atom. 7. Bohr's explanation of the laws governing the spectrum of the hydrogen atom. Difficulties of the Bohr model of the atom. 8. De Broglie's hypothesis. Wave properties of particles. Experiments on particle diffraction. 9. Wave function and its statistical interpretation. 10. Eigenstates. Schrödinger equation. 11. Passage of a particle through a potential barrier. tunnel effect. 12. Quantum theory of the hydrogen atom. Quantum numbers n, l, m, s, their meaning. Spatial quantization. 13. Electron spin. Spin magnetic moment. Doublet nature of the spectra of alkali metals. 14. Experience of Stern and Gerlach. 15. Multi-electron atom. Quantum numbers of an atom. 16. Pauli principle. Electronic shells and subshells. 17. Quantum mechanical explanation of the periodic table. 18. Physics of the nucleus. 19. Elementary particles.

**Exam ticket sample:**

FGBOU VO "Bashkir State University"
PHYSICAL AND TECHNICAL INSTITUTE
Department of General Physics

EXAMINATION TICKET No. 5
in **Physics**
Direction/specialty 01.03.02 Applied mathematics and informatics
Profile **"Applied programming and data analysis"**

1. Energy of a rotating and rolling body. Rotary work.
2. Corpuscular-wave dualism of the properties of matter.

Approved at the meeting of the department _____, protocol No. ___ (the date)

Head of Department of General Physics_____ (signature)

As part of the use of the module-rating system of education and student performance assessment, the final assessment of the student's knowledge in the discipline is made by the sum of the points obtained in the current and boundary control of knowledge, skills and abilities during the semester, and the points obtained in the exam. For work in a semester, a student receives up to 70 points for completing tasks within the framework of current and midterm control and an additional 10 points for the results of participation in the Olympiad of students in general physics, publication of articles and for working with schoolchildren. To be admitted to the exam, the student must score at least 35 points in the semester. The maximum number of points a student can receive in the exam is 30 points.

***Evaluation criteria (in points):***

- **25-30 points** are given to the student if the student gave complete, detailed answers to all the theoretical questions of the ticket, demonstrated knowledge of terminology, basic elements, the ability to apply theoretical knowledge when performing practical tasks. The student answered all additional questions without difficulty;

- **17-24 points** are given to a student if the student has revealed mainly theoretical questions, but there are inaccuracies in the definition of basic concepts. When answering additional questions, minor inaccuracies were made;
- **10-16 points** are given to a student if, when answering theoretical questions, the student made several significant errors in the interpretation of basic concepts. The logic and completeness of the answer suffer from noticeable flaws. Gaps in knowledge of the basic methods are noticeable. On the whole, the theoretical questions are presented sufficiently, but with material omissions. There are fundamental errors in the logic of constructing an answer to a question;
- **1-10 points** are given to a student if the answer to theoretical questions indicates a misunderstanding and an extremely incomplete knowledge of the basic concepts and methods. The student was unable to answer any of the additional questions.

## Test tasks

### *Test structure №1*

Consist of three options for 20 test questions, each of them. 10 questions on knowledge of terms, formulations of basic laws, basic formulas. Each theoretical question has 4 possible answers, only one of them is correct. Other questions require the ability to solve problems, explain physical phenomena. They usually require a numerical answer, with no suggested options. The student performs one option in the simulator mode as directed by the teacher. You have 1 hour to complete the option. The second version of the test is performed for evaluation.

**Пример части варианта №1 теста**

1. Select a formula for calculating the moment of inertia of a body about an arbitrary axis.

а) $J = \frac{3}{2}mR^2$ б) $J = J_0 + md^2$ в) $J = \frac{1}{2}mR^2$ г) $J = \frac{1}{3}ml^2$

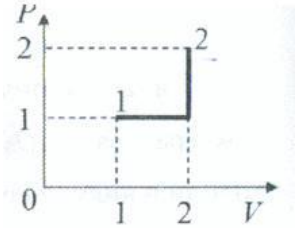
2. A boy rolls a hoop along a horizontal road at a speed v = 2 m/s. To what height H can the hoop roll up the hill due to its kinetic energy? Specify the numerical answer in m. Do not write the dimension.
3. A gas is considered ideal if we can neglect:

A. by interaction of molecules;
B. by the speed of molecules;
C. by molecular size;
D. by collisions of molecules.
F. mass of molecules;

a) A, F b) A, B c) A, C d) B, D

4. The pressure of an ideal gas depends on:
   1. forces of attraction of molecules;
   2. kinetic energy of molecules;
   3. potential energy of molecules;
   4. sizes of molecules;

5. The state of the ideal gas has changed according to the p-V graph in the diagram. In state 1 gas temperature is $T_o$. What is the gas temperature in state 2?
   Give your answer as a number in units of $T_o$.




***Criteria for evaluating test No. 1 (in points):***

The correct answer to any question of the test is estimated at 0.5 points. All scores are added up. Maximum score =10. Wrong answer - 0 points.

### *Test structure №2*

They consist of three options with 20 test questions in each of them. 10 questions are on knowledge of terms, formulations of basic laws, basic formulas. Each theoretical question has 4 possible answers, only one of them is correct. Other questions require the ability to solve problems, explain physical phenomena. They usually require a numerical answer, with no suggested options. The student performs one option in the simulator mode as directed by the teacher. You have 1 hour to complete the option. The second version of the test is performed for evaluation.

### *An example of a part of Test No. 2 on electricity and optics.*

1. A flat capacitor is charged up to a potential difference U = 1 kV. The distance d between the plates is 1 cm. The dielectric is glass (ε = 7). Determine the volumetric energy density of the capacitor field. Give a numerical answer in J / $m^3$ (do not write the unit).
2. A coil with a resistance R = 0.1 Ohm was connected to a current source with an EMF ε = 1.5 V. The ammeter showed a current strength equal to $I_1$ = 0.5 A. When another current source with the same EMF was connected in series to the current source, the current strength in the same coil turned out to be 0.4 A. Determine the internal resistance of the second current source. Give a numerical answer in Ohms (do not write the dimension).
3. What are the names of dielectrics with a high value of permittivity? a) piezoelectrics; b) electrets; c) ferroelectrics; d) pyroelectrics;
4. What is the name of the coefficient χ in the formula for the polarization vector of an isotropic dielectric $\vec{P} = \chi\varepsilon_0\vec{E}$ ?
   a) electrical constant; b) magnetic constant; c) dielectric susceptibility of the substance; d) permittivity of the medium;
5. What is the name of the optical characteristic of a medium, which shows how many times the phase velocity of light in a given medium is less than the speed of light in vacuum? a) absolute refractive index; b) refractive index; c) relative refractive index; d) optical refractive index;
6. Which of the following formulas expresses the phase speed of light?
   a) $w = \frac{u + \upsilon}{1 + u\upsilon/c^2}$ b) $\upsilon = \frac{c}{\sqrt{\varepsilon\mu}}$ c) $\upsilon = \omega R$ d) $\upsilon = \upsilon_0 + at$
7. What is the name of the ratio of the luminous flux to the value of the solid angle within which this luminous flux propagates? a) light intensity; b) luminosity; c) luminous flux; d) light intensity;
8. A lamp suspended from the ceiling gives a luminous intensity of I = 60 cd in the horizontal direction. What luminous flux Φ falls on a painting with area S = 0.5 m2, hanging vertically on the wall at a distance r = 2 m from the lamp, if there is a large mirror on the opposite wall at a distance a = 2 m from the lamp? Give a numerical answer in Lumens (do not write the unit).
9. In what direction does a swimmer diving into the water see the setting Sun? The angle is measured from the surface of the water. Give a numerical answer in degrees (do not write the dimension).

### *Evaluation criteria for test No. 2 (in points):*

The correct answer to any question of the test is estimated at 0.75 points. All scores are added up. Maximum score = 15. Wrong answer - 0 points.

### *The structure of test number 3 in quantum physics*

They consist of three options with 20 test questions in each of them. 10 questions are on knowledge of terms, formulations of basic laws, basic formulas. Each theoretical question has 4 possible answers, only one of them is correct. Other questions require the ability to solve prob-

lems, explain physical phenomena. They usually require a numerical answer, with no suggested options. The student performs one option in the simulator mode as directed by the teacher. You have 1 hour to complete the option. The second version of the test is performed for evaluation.

***An example of part of option No. 1 of test No. 3 in "Quantum Physics"***

1. What is the physical meaning of the squared modulus of the wave function?
a) it determines the probability of finding a microparticle at a fixed point in time at a given point in space; b) it determines the probability of finding a microparticle for a certain period of time in a small region of space; c) it determines the probability of finding a microparticle at a fixed point in time in a small region of space; d) it determines the probability of finding a microparticle for a certain period of time at a given point in space;
2. Choose a formula for calculating the kinetic energy of a quantum particle in a "potential well":

a) $E = h\nu$ b) $E = \frac{mc^2}{\sqrt{1-\nu^2/c^2}}$ c) $E = \frac{n^2\pi^2\hbar^2}{2ml^2}$ d) $E = mc^2$

3. Find the radius of the first Bohr electron orbit for singly ionized helium. Give a numerical answer in pm (do not write the dimension).
4. Find the magnetic orbital moment of the p-electron in the hydrogen atom. Give a numerical answer in Bohr magnetons (do not write dimensions).

***Criteria for evaluating test No. 3 (in points):***

The correct answer to any question of the test is estimated at 0.25 points. All scores are added up. Maximum score = 5. Wrong answer corresponds to 0 points.

## Laboratory practice.

### Structure of laboratory works

The student performs 8 laboratory works in the allotted time according to the curriculum (one work each in the laboratories of mechanics and molecular physics, 2 works in the laboratory of electricity and magnetism, 2 works in the laboratory of optics, 2 works in the laboratory of atomic physics). 2 academic hours of classroom studies are allotted for the performance of one work. Teaching aids in laboratories for each laboratory work are available. Under the performance of laboratory work is understood: obtaining a permit for measurements (the presence of a summary in a notebook and knowledge of the device and principle of operation of a laboratory installation); performing measurements; performing calculations and writing a written report in a notebook, defending laboratory work (answers to questions at the end of the training manual). The processing of experimental data is necessarily carried out using computer technologies (for example, Microsoft Excel or other available programs).

### Topics of laboratory work

***Mechanics (room №204)***

No. 1 “Measuring the linear dimensions of bodies. Volume Calculation.

No. 2 "Atwood's Machine".

No. 3 "Study of the dynamics of the rotational motion of a rigid body."

№4 "Determination of the moment of inertia of bodies and verification of the Huygens-Steiner theorem by the method of torsional vibrations."

No. 5 "Determination of the coefficients of sliding friction and rolling friction using an inclined pendulum."

No. 6 "Study of the elastic characteristics of materials."

No. 7 "Movement of Maxwell's pendulum".

No. 8 "Studying the precession of a gyroscope."

No. 9 "Studying the gyroscope."

No. 10 "Collision of balls."

No. 11 "Checking the law of conservation of momentum in the collision of balls."

No. 12 "Determination of the acceleration of free fall."

№13 "Determination of the acceleration of gravity with the help of mathematical and physical pendulums."

№14 "Determination of coefficients of sliding friction and rolling friction".

No. 15 "Study of a torsion ballistic pendulum".

No. 16 "Study of natural vibrations of a lumped system."

No. 17 "Study of beats."

№18 "Study of vibrations of coupled systems".

No. 19 "Maxwell's Pendulum".

No. 20 "Measurement of the speed of sound in air by the method of adding mutually perpendicular vibrations."

№21 "Determining the flight speed of a "bullet" by the method of a torsion ballistic pendulum and determining the moments of inertia of solid bodies."

No. 22 "Determination of Young's modulus by the bending method."

### *Molecular physics (room №308)*

No. 1. Determination of the coefficient of viscosity of air by capillary method. No. 2. Determination of the ratio of specific heat capacities of gases by the Clement and Desormes method. Number 3. Determination of the coefficient of thermal conductivity by the heated thread method. No. 4. Determination of the universal gas constant by the method of isothermal change of state. No. 5. Determination of the mean free path of air molecules. No. 6. Determination of the ratio of heat capacities of air at constant pressure and volume. No. 7. Determination of the coefficient of volumetric expansion of a liquid by the method of Dulong and Petit. No. 8. Determination of the coefficient of surface tension of a liquid. Determination of the coefficient of surface tension of a liquid in capillary tubes. No. 9. Study of the dependence of the surface tension coefficient of the solution on concentration and temperature. No. 10. Determination of the coefficient of internal friction of a liquid by the Stokes method. No. 11. Determination of the coefficient of surface tension of a liquid by the method of tearing off the ring. No. 12. Determination of the speed of sound in air and the ratio of specific heat capacities by the standing wave method. No. 13. Determination of the heat capacity of solids. No. 14. Determination of the coefficient of mutual diffusion of air and water vapor. No. 15. Determination of the ratio of heat capacities of air at constant pressure and volume by the resonance method. No. 16. Determination of the heat of vaporization of water. No. 18. Determination of heat of fusion of metal and increment of entropy.

### *Electricity and magnetism (room №305)*

1. The study of the law of distribution of random variables and its main characteristics on the example of measuring the resistance of a resistor. 2. The study of systematic errors on the example of measuring the resistance of a resistor by the method of an ammeter and a voltmeter. 3. Study of the device and familiarization with some applications of an electronic oscilloscope. 4. Studying the operation of an electronic voltmeter. 5. The study of compensators (potentiometers) and their application for measuring EMF, voltage and quantities functionally related to them. 6. The study of measuring bridges and their application to determine the parameters of electrical circuits. 7. Study of the movement of the movable frame of the Galvanometer of the magnetoelectric system and studies of the main modes of its operation. 8. Study of magnetic flux, magnetic induction and magnetic field strength. 9. The study of electric fields using an electric bath and

electrically conductive paper. 10. Investigation of electrical conductivity and the Hall effect in order to determine the concentration of current carriers, their mobility and energy of the band gap of the conductor. 11. Study of the properties of ferroelectrics. 12. Study of the earth's magnetic field and determination of the electrodynamic constant using a tangent - galvanometer. 13. Determination of the specific charge of an electron by the method of magnetic focusing. 14. Study of the trajectories of electrons under the action of electric and magnetic fields and measurement of the specific charge of an electron by the magnetron method 15. Study of the magnetic properties of substances. 16. Study of Ohm's law of alternating current 17. Study of damped oscillations in an oscillatory circuit. 18. Study of forced oscillations in an oscillatory circuit. 21. Computer simulation of electrostatic fields of charge systems 25. Studying the principle of operation and the main characteristics of electrical measuring instruments.

***Optics (room №310)***

No. 2. Determination of the radius of curvature of the lens and the wavelength of light using Newton's rings. Number 3. Interference: stripes of equal thickness. No. 4. Study of the diffraction grating. No. 5. Investigation of the dependence of the emissivity integral and verification of the Stefan-Boltzmann law. No. 6. Study of polarization-optical phenomena. No. 7. Spectroscopic study of the chromatic polarization of light. No. 8. Study of the phenomenon of natural rotation of the plane of polarization. No. 9. Study of the phenomenon of light diffraction. No. 10. Determination of the focal lengths of the positive and negative lenses and the positions of the main planes of a complex optical system. No. 11. Study of absorption and transmission spectra. No. 14. Determination of the refractive index and average dispersion of liquids and solids using an ABBE refractometer. No. 15. Determination of the dispersion of glass prisms using a goniometer. No. 16. Determination of focal lengths and positions of principal planes of a two-lens optical system. No. 17. Determination of focal lengths of positive and negative lenses by the Bessel method. No. 18. Determination of the main characteristics of a diffraction grating. No. 19. Study of Fraunhofer diffraction in coherent laser light. No. 24. Study of the laws of equilibrium thermal radiation.

***Laboratory of Atomic Physics (room No. 211)***

1. Laboratory work No. 1 "Laws of the photoelectric effect";
2. Laboratory work No. 2 "Determination of the excitation potentials of argon atoms (experiment of Frank and Hertz)";
3. Laboratory work No. 4 "Study of the radiation spectrum of the hydrogen atom and the determination of the Rydberg constant";
4. Laboratory work No. 6 "Study of the helium-neon laser";
5. Laboratory work No. 7 "Studying of the simple Zeeman effect";
6. Laboratory work No. 9 "Study of electron diffraction and determination of interplanar distances of a polycrystal";
7. Laboratory work No. 10 "Study of the fine structure of the sodium atom";
8. Laboratory work No. 12 "Emission spectral analysis of alloys on the steeloscope SL-13";
9. Laboratory work No. 16 "Studying the structure of the spectrum of a diatomic molecule."

**Criteria for evaluating the performance and defense of laboratory work**

Criteria for evaluating the performance and defense of laboratory work 1 point is given for passing the permit to work, 1 point is given for performing measurements, 1 point is given for performing calculations and drawing up a report. For defending a report on laboratory work, a student can get 0-2 points (2 points - complete answers without comments, 1 point - for answers with minor errors, 0 points - for no answers or fundamentally wrong answers). The maximum score for the performance and defense of laboratory work is 5 points. Laboratory work performed in the course of studying the discipline is described in the guidelines available in the laboratory and in the electronic network of Bashkir State University:

**Examples of control questions for laboratory work:**

***Control questions for the defense of laboratory work No. 19 in optics*** "Study of Fraunhofer diffraction in coherent laser light"

1. Formulate the Huygens-Fresnel principle and write its analytical expression.

2. What phenomenon is called diffraction? When is Fraunhofer diffraction observed? And when - Fresnel diffraction?

3. Write down the conditions of diffraction minima and maxima for one or two slits.

4. What is the maximum width of the slit at which intensity minima will still be observed?

5. Why are there no additional maxima in the distribution of diffraction intensity from two slits?

6. How does an increase in the wavelength and slit width affect Fraunhofer diffraction from one slit?

7. How will the diffraction pattern change as the screen moves away from the slit?

8. Explain the principle of operation of a helium-neon laser and describe the properties of laser radiation.

***Control questions for the defense of laboratory work No. 10 in atomic physics "The study of the fine structure of the spectrum of the atom":***

What is the fundamental difference between the energy levels of alkaline elements and the levels of the hydrogen atom? 2. What causes a quantum defect? 3. Give a qualitative explanation of the dependence of a quantum defect on the orbital number 4. Write down the spectral series of alkaline elements. 5. How to explain the doublet structure of the spectra of alkaline elements? 6. What interaction is responsible for the fine splitting of the energy spectra of atoms? 7. Decipher the record of the states of the atom $^2P_{1/2}$, $^3P_2$, $^2D_{5/2}$, $^1F_3$. 8. Explain the sharpness and blurring of the lines of the sharp and diffuse series, respectively. 9. Determine the energy difference between the states $3^2P_{3/2}$ and $3^2P_{1/2}$ of the sodium atom. 10. Construct a scheme of quantum transitions of the sodium atom from the 5F state to the ground state that are admissible according to the selection rules.

***Control questions for the defense of laboratory work No. 4 in atomic physics "Study of the emission spectrum of the hydrogen atom and definition of the Rydberg constant":***

1. What is called a spectral series? 2. What is called the boundary of the series? 3. Write the generalized Balmer formula for a hydrogen-like atom. 4. What is the limit of the Lyman series? limit of the Balmer series? 5. What is called a spectral term? 6. Formulate the Ritz combination principle. What is the relationship between Bohr's theory and Ritz's combination principle? 7. Formulate Bohr's frequency rule. 8. Derive the formula for the quantization condition for electron orbits (Bohr's second postulate). 9. What is called an isotopic shift? How does the spectrum of light hydrogen differ from the spectrum of deuterium and tritium (heavy hydrogen)? 10. What quantum numbers describe the state of an electron in a hydrogen atom? What is their physical meaning? 11. What states are called degenerate? What is the degree of degeneracy of the nth level in the hydrogen atom? 12. How are the states of an electron classified according to the orbital quantum number? 13. What is the modulus of orbital momentum d - electron in units of ħ? 14. Determine in units of ħ the possible values of the projection of the orbital angular momentum of the f-electron. 15. What do you know about the selection rules? 16. What is spin? What is the spin quantum number of an electron? 17. Define the fine structure of levels. 18. What is spin-orbit interaction? 19. Draw a diagram of the energy levels of the hydrogen atom, taking into account the spin-orbit interaction.

## 5. Educational, methodological and information support of the discipline

### *5.1. List of basic and additional educational literature necessary for mastering the discipline*

#### Main literature:

1. Trofimova T.I. Physics course: textbook. allowance for universities .– Ed. 14th, sr. - M.: Academy, 2007. – 560 p. – (Higher professional education).
2. Irodov I.E. / Problems in general physics. – Ed. 8th. - St. Petersburg: Doe. , 2007. - 432 p.

#### Additional literature:

1. Strelkov S.P. Mechanics. - St. Petersburg: Lan, 2010. - 560 p.
2. Saveliev I.V. General physics course [Electronic resource]: in 3 vols. / I. V. Saveliev. - St. Petersburg. : Doe, 2007 - ISBN 978-5-8114-0684-5.T. 1: Mechanics. Molecular Physics. - 11th ed. - 2011. - 352 p.: ill.
3. Trofimova T.I., Firsov A.V. Physics course with examples of problem solving: v. 1.: textbook / M .: KNORUS, 2015. – 584 p.

### *5.2. List of resources of the information and telecommunications network "Internet" and software required for mastering the discipline*

1. Electronic library system. EB BashGU. - Own electronic library of educational and scientific electronic publications, which includes publications of BashSU teachers. Authorized password access from anywhere on the Internet. Registration in the BashSU Library, further access from anywhere on the Internet. – https://elib.bashedu.ru/
2. Electronic library system. Online university library. – Full-text database of educational and scientific electronic publications. Authorized password access from anywhere on the Internet. Registration in the BashSU Library, further access from anywhere on the Internet. – https://biblioclub.ru/
3. Electronic library system of the publishing house .Lan. – Full-text database of educational and scientific electronic publications. Authorized password access from anywhere on the Internet. Registration in the BashSU Library, further access from anywhere on the Internet. – https://e.lanbook.com/
4. Electronic catalog of the BashSU Library - Reference and search apparatus of the library. Includes a system of catalogs and card indexes, a reference and bibliographic fund. - http://www.bashlib.ru/catalogi/

#### Additional literature in EBS of BashSU:

1. The study of beats [Electronic resource]: laboratory work on mechanics No. 17 / BashGU: G. R. Akmanova, R. R. Shafeev. - Ufa: RIO BashGU, 2010 - <URL: https://elib.bashedu.ru/dl/corp/AkmanovaShafievLab.rab.poMehanike.17.2010.pdf>
2. The study of the gyroscope [Electronic resource]: laboratory work on mechanics / G.R. Akmanova; R.R. Shafeev. - Ufa: RIO BashGU, 2012. - Electron. print version. publications. – URL:https://elib.bashedu.ru/dl/corp/AkmanovaShafievLab.rab.poMehanike.9.2012.pdf
3. Studying the laws of kinematics and dynamics of the translational motion of a rigid body on the Atwood machine [Electronic resource]: laboratory work on mechanics No. 2 / G.R. Akmanova; R.R. Shafeev. - Ufa: RIO BashGU, 2013. - Electron. print version. publications. – URL:https://elib.bashedu.ru/dl/corp/AkmanovaShafievIzuch.zakKinematikiLab.2.2013.pdf
4. Studying the law of conservation of momentum [Electronic resource]: laboratory work on

mechanics No. 10 / G.R. Akmanova; R.R. Shafeev. - Ufa: RIO BashGU, 2013. - Electron. print version. publications. – URL:https://elib.bashedu.ru/dl/corp/AkmanovaSh.Izuch.ZakonaSoh.Impulsa.Lab.rab.poMeh.10.2013.pdf

5. Determination of the coefficients of friction and sliding and rolling friction using an inclined pendulum [Electronic resource]: laboratory work on mechanics No. 5 / G.R. Akmanova; R.R. Shafeev. - Ufa: RIO BashGU, 2013. - Electron. print version. publications. – URL:https://elib.bashedu.ru/dl/corp/AkmanovaShafievOpred.koef.Lab.rab.poMehanike.5.2013.pdf

6. Determination of the universal gas constant by the method of isothermal change of state [Electronic resource]: laboratory work on molecular physics No. 4 / F.M. Girfanova; R.R. Shafeev. - Ufa: RIC BashGU, 2014. - Electron. print version. publications. – URL:https://elib.bashedu.ru/dl/corp/GirfanovaShafeevLabRabMolekFizike4.pdf

7. Determination of the coefficient of volumetric expansion of a liquid by the Dulong and PTI method [Electronic resource]: laboratory work on molecular physics No. 7 / F.M. Girfanova; R.R. Shafeev. - Ufa: RIC BashGU, 2015. - Electron. print version. publications. – URL:https://elib.bashedu.ru/dl/local/Girfanova_Shafeev_sost_lab_7_mu_2015.pdf

8. Studying the dependence of the surface tension coefficient of a solution on concentration and temperature [Electronic resource]: laboratory work on molecular physics No. 9 / F.M. Girfanova; R.R. Shafeev. - Ufa: RIC BashGU, 2015. - Electron. print version. publications. – URL:https://elib.bashedu.ru/dl/local/Girfanova_Shafeev_sost_lab_9_mu_2015.pdf

9. Zamanova, G.I. Theory of errors. Tasks and tests in mechanics and molecular physics. [Electronic resource]: textbook. allowance / G.I. Zamanova, R.R. Shafeev; - Ufa: RIC BashGU, 2016. - Electron. print version. publications. – URL:https://elib.bashedu.ru/dl/read/Zamanova_Shafeev_Teorija pogreshnostej_Zadachi_up_2016.pdf

10. Girfanova F. M. Determination of the coefficient of surface tension of a liquid by the method of tearing off the ring: laboratory work in molecular physics No. 11 for students. 1st year PhTI BashGU Ufa: RIC BashSU, 2014 Electron. print version. publications. <URL: https://elib.bashedu.ru/dl/corp/GirfanovaLabRabMolekFizika11.pdf/info>.

11. Almukhametov R. F.; Zamanova G.I.; Gafurov IG Determination of the specific charge of an electron by the method of magnetic focusing: method. instructions for performing laboratory work No. 13 on electricity Ufa: RIC BashGU, 2016. Electron. print version. publications. URL:https://elib.bashedu.ru/dl/local/Almuhametov_Zamanova_Gafurov_sost_MU 13_Opredelenie udelnogo zarjada elektrona_mu_2016.pdf

12. Almukhametov R. F. Study of the trajectory of electrons under the influence of electric and magnetic fields and determination of the specific charge of an electron by the magnetron method: guidelines for performing laboratory work No. 14 on electricity Ufa: RIC BashGU, 2019 Electron. print version. publications. URL:https://elib.bashedu.ru/dl/local/Almuhametov_sost_Lab 14_Elektr zarjad_mu_2019.pdf

13. Almukhametov R. F.; Gafurov IG Investigation of damped electrical oscillations in an oscillatory circuit: method. instructions for performing laboratory work No. 17 on electricity. Ufa: RIC BashGU, 2016. Electron. print version. publications. — URL:https://elib.bashedu.ru/dl/local/Almuhametov_Gafurov_sost_MU_17_Issledovanie_zatuhajuschih elektricheskih kolebanij_mu_2016.pdf

14. Gorbenko A. P.; Akmanova G. R.; Shafeev R. R. Investigation of the phenomena of light diffraction: laboratory work on optics No. 9. Ufa: RIO BashGU, 2012. Electron. print version. publications.
URL:https://elib.bashedu.ru/dl/local/GorbenkoAkmanovaChafeevLabRabPoOptike.9.2012.pdf

15. Balapanov M. Kh.; Akmanova GR Determining the focal lengths of positive, negative lenses and a complex optical system: laboratory work on optics No. 10 for students of natural faculties and the Institute of Physics and Technology. Ufa: RIC BashGU, 2018. Electron. print

version. publications. — <URL: https://elib.bashedu.ru/dl/local/Balapanov_Akmanova_sost_Opred fokusn rass pol i otr linz_lab 10 optika_mu_2018 (2).pdf>.

16. Abdullin A. U.; Akmanova G. R.; Shafeev R. R. The study of polarization-optical phenomena: laboratory work on optics No. 6 for students of the Institute of Physics and Technology. Ufa: RIC BashGU, 2020. Electron. print version. publications. URL:https://elib.bashedu.ru/dl/local/Shafeev_R_R_Akmanova_G_R_Abdullin_A_U_Izuchenie_polyarizacionno-optich_yavlenie_6_2020.pdf

17. Akmanova G. R.; Gafurov I. G. Study of absorption and transmission spectra: laboratory work on optics No. 11 for students of natural faculties and the Institute of Physics and Technology. Ufa: RIC BashGU, 2018. Electron. print version. publications. URL:https://elib.bashedu.ru/dl/local/Akmanova_Gafurov_sost_Issled spektrov_Lab 11 optika_mu_2018.pdf

18 Balapanov M. Kh.; Akmanova G. R. Determination of the dispersion of glass prisms using a goniometer: laboratory work on optics No. 15 for students of the Physics and Technology Institute and natural faculties Ufa: RIC BashGU, 2018. Electron. print version. publications. <URL: https://elib.bashedu.ru/dl/local/Balapanov_Akmanova_sost_Opred dispersii_Lab 15 optika_mu_2018.pdf>

19. Balapanov M. Kh.; Zamanova GI Study of the basic laws of the photoelectric effect: method. instructions for the implementation of laboratory work No. 1 in atomic physics. Ufa: RIC BashGU, 2013. Electron. print version. publications. < >. <URL: https://elib.bashedu.ru/dl/local/Balapanov_Zamanova_sost_MU k laboratornoj rabote 1 po atomnoj fizike_mu_2013.pdf>.

20. Ishembetov R.Kh. Studying the absorption of cosmic radiation in lead: guidelines for performing laboratory work No. 3 in nuclear physics. Ufa: RIC BashGU, 2019. Electron. print version. publications. URL:https://elib.bashedu.ru/dl/local/Ishembetov_sost_Izuchenie pogloschenija_lab 3 po jad fiz_mu_2019.pdf

## 6. Material and technical base necessary for the implementation of the educational process in the discipline

The material and technical base necessary for the implementation of the educational process in the discipline is given in the table:

| *Name of specialized classrooms, classrooms, laboratories* | *Type of classes* | *Name of equipment, software* |
|---|---|---|
| Large Lecture Hall 501 | Lections | Whiteboard, computer, multimedia projector, screen Software: 1. Windows 8 Russian. Windows Professional 8 Russian Upgrade. OLP NL Academic Edition license, perpetual. Agreement No. 104 dated 06/17/2013 2. Microsoft Office Standard 2013 Russian. OLP NL Academic Edition license, perpetual. Agreement No. 114 dated November 12, 2014 |
| Laboratory of Mechanics 204 (Physical and Mathematical Corpus) | Labs | Educational furniture, board. Laboratory installation. "Young's modulus and shear modulus" FM19 (with electronic unit FMSh-1); Laboratory installation. "Gyroscope" FM 8; Laboratory installation. "Collision of balls" FM17; Laboratory installation. "Maxwell's pendulum" FM19; Laboratory installation. Atwood Machine FM 2 Laboratory installation. "Inclined pendulum" FM 5; Laboratory installation. "Unifilar suspension with a gun" FM15; Laboratory installation. "Torsional ballistic pendulum with a millisecond watch" FPM-09; Laboratory installation. "Oberbeck's pendulum" FPM-06 with a set of weights and a millisecond watch; Laboratory installation. "Gyroscope" FPM-10; Equipment for LR No. 6 "Study of the elastic characteristics of materials": a device for determining the elongation of the wire, an illuminator with a translucent millimeter scale, a torsion pendulum; Equipment for LR No. 4 "Determination of the moments of inertia of bodies and verification of the Huygens-Steiner theorem": trifilar suspension, two cylinders; Equipment for LR No. 16 "Study of natural vibrations of a lumped system": a tripod, a set of springs and weights; Equipment for LR No. 17 "Study of beats": installation for studying oscillations in a coupled system with two mathematical pendulums; Equipment for LR No. 20 “Measuring the speed of sound in air by adding mutually perpendicular oscillations”: sound generator GZ-18, oscilloscope C1-1, optical bench, microphone, speaker; Caliper ШЦ-125-0.1-10 pcs; Caliper 150 mm.-15 pcs; Smooth micrometer 0.01 mm.MK 75 - 15 pcs; Micrometer MK 25 class 1GU - 10 pcs; Alcohol thermometer - 1 pc. |
| Laboratory of Molecular Physics 308 (Physical and Mathematical Building) | Labs | Equipment: Educational furniture, board. Installation for LR No. 3 "Determination of the thermal conductivity by the heated filament method" FPT1-3 - 1 pc. Installation for LR No. 6 "Determining the ratio of heat capacities of air at constant pressure and volume" FPT1-6 - 1 pc. Installation for LR No. 15 "Determination of the ratio of heat capacities of air at constant pressure and volume by the resonance method" FPT1-7 - 1 pc. Installation for LR No. 4 "Determination of the universal gas constant by the method of isothermal change of state" FPT1-12 - 1 pc. Installation for LR No. 5 "Determination of the mean free path of air molecules" - 1 pc., Aspirator - 1 pc., Beaker - 1 pc. Installation for LR No. 7 "Determination of the coefficient of volumetric expansion of a liquid by the Dulong and Petit method" - 1 pc. Liquid manometers - 4 pcs. to LR No. 2, to LR No. 4, to LR No. 5, to LR No. 9; Aneroid barometer - 1 pc., Three-way valve - 1 pc. to LR No. 4 "Determination of the universal gas constant by the method of isothermal change of state"; Generator - 1 pc., Oscilloscope - 1 pc., Resonator with microphone and speaker - 1 pc. to LR No. 12 "Determination of the speed of sound in air and the ratio of specific heat capacities by the |

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| | | standing wave method"; Komovsky pump to LR No. 2 "Determination of the ratio of specific heat capacities of gases by the Clement and Desormes method"; Cathetometer - 1 pc., A set of capillary tubes with a holder - 1 pc. to LR No. 8 “Determination of the coefficient of surface tension of a liquid. Determination of the coefficient of surface tension of a liquid in capillary tubes. Cantor-Rebinder device - 1 pc. to LR No. 9 “Study of the dependence of the surface tension coefficient of the solution on concentration and temperature”; Ring on the suspension - 1 pc., Caliper - 1 pc., A set of weights - 1 pc. to LR No. 11 "Determination of the coefficient of surface tension of a liquid by the method of tearing off the ring"; Crucible furnace with tin - 1 pc., Thermocouple - 1 pc., Stand - 1 pc., Galvanometer - 1 pc. to LR No. 18 "Determination of the heat of fusion of metal and increment of entropy" Water distiller - 1 pc. |
| Laboratory of Electricity and Magnetism 305 (Physical and Mathematical Building) | Labs | Educational furniture, board.<br>Installation to the lab. work No. 2 "The study of systematic errors on the example of measuring the resistance of a resistor by the method of an ammeter and a voltmeter", Equipment for laboratory work No. 3 "Study of an electronic oscilloscope and familiarization with some of its applications"; Equipment for laboratory work No. 4 "Studying the operation of an electronic voltmeter"; Equipment for laboratory work No. 6 "Study of measuring bridges and their application for determining the parameters of electrical circuits"; Equipment for laboratory work No. 12 "Research of the Earth's magnetic field and determination of the electrodynamic constant using a tangent-galvanometer"; Equipment for laboratory work No. 13 "Determination of the specific charge of an electron by the method of magnetic focusing"; Equipment for laboratory work No. 14 “Investigation of the trajectory of electrons under the influence of electric and magnetic fields. Determination of the specific charge of an electron by the magnetron method”; Equipment for laboratory work No. 15 "Study of the magnetic properties of ferromagnets"; Equipment for laboratory work No. 16 "Checking the complete Ohm's law for alternating current"; Equipment for laboratory work No. 17 "Investigation of damped electrical oscillations in an oscillatory circuit"; Equipment for laboratory work No. 18 "Study of forced electrical oscillations in an oscillatory circuit"; Equipment for laboratory work No. 21 "Modeling of electrostatic fields of charge systems on a computer"; Equipment for laboratory work No. 26 a “Checking Ohm's law. Determination of the resistivity of the conductor"; Equipment for laboratory work No. 26 b "Study of the polarization of dielectrics." |
| Laboratory of optics 310 (Physical and Mathematical Building) | Labs | Goniometer UG-3 Goniometer Gs-5 inv.1101040179 Polariscope PKS-125 RMS student workplace No. 11 "Absorption and transmission spectra" Inv. 1101043597 RMS student workplace No. 19 "Dispersion and diffraction" (LRMS with a spectral illuminator) inv.1101043309 RMS student workplace No. 9 "Dispersion and diffraction" (LRMS with a spectral illuminator) inv. 1101043432 RMS student workplace No. 16 "Geometric optics" (LRMS with LED illuminator) RMS student workplace "Diffraction" (LRMS with a laser illuminator for studying diffraction) Inv. 1101043428 RMS student workplace "Interference" (LRMS with a laser illuminator for interference research) inv.1101043429 Spotting scope Inv.2101042070 Laser element inv.2101042469 Luxmeter Yu-116 laboratory tables -20 pcs. chairs -40 pcs. |
| Laboratory of atomic physics 212 (Physical and Mathematical Building) | Labs | Equipment:<br>Educational furniture, board.<br>Installation for studying the basic laws of the photoelectric effect Measuring device for studying the external photoelectric effect FPK-10, replaceable photocell. Installation for studying the experience of Frank and Hertz: thyratron TG-0.1-0.3 with argon filler, adjustable power supply, 0.1 A ammeter inv. IH6348, 3 V voltmeter, 30 V voltmeter, microammeter, control panel. Two-channel |

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| | | oscilloscope S1-220, Installation for determining the resonant potential by the method of Frank and HertzFPK-02 (Measuring device No. 714, object of study No. 714). Installation for studying the emission spectrum of a hydrogen atom and determining the Rydberg constant: MUM monochromator for FPK 09 Installation for studying the spectrum of the hydrogen atom FPK 09 Installation for studying a helium-neon laser: 1) Laser source IL-1 No. 0028 01.98 optical bench; 3) polaroid; 4) diffraction grating; 5) screen. Student's workplace for studying electron diffraction and determining the interplanar distances of a polycrystal: set of diffraction patterns, measuring microscope MIR-12 No. 230510. Installation for studying the fine structure of the spectrum of the sodium atom: three-prism glass spectrograph ISP-51 No. 570096, sodium spectral lamp, mercury spectral lamp, lens (F=94), measuring microscope, fan, starting device (choke) No. 630246 inv. 354516. Installation for emission spectral analysis of alloys: steeloscope SL-13 No. 908048 Inv. 013/1-0003909, test samples. Installation for studying the structure of the spectrum of a diatomic molecule: three-prism glass spectrograph ISP-51 with an autocollimation camera UV-90 No. 600330, lens (F=94). Universal monochromator UM-2 Installation for studying the spectrum of the hydrogen atom. Determination of the Rydberg constant (Planck on the spectrum of the hydrogen atom FKL-01. Installation for studying the spectrum of the hydrogen atom using a diffraction grating. Determination of the Rydberg Planck constant from the spectrum of the hydrogen atom FKL-01 (M). Educational laboratory "Laboratory installation" Atom in a magnetic field. Zeeman effect FKL-02 M-1 K. Training installation "Study of the external photoelectric effect and determination of Planck's constant" FKL-11M. Experience of Frank and Hertz FKL-06. Training laboratory installation "Study of the spectra of alkali metals on the example of the spectrum of the sodium atom FKL-02. |
| Reading room №1 ((Main Building)1 этаж) | Independent work | Scientific and educational fund, scientific periodicals, PC (monoblock) - 3 pcs, Wi-Fi access for mobile devices, unlimited access to ELS and database; number of seats - 76. |
| Reading room №2 (Physical and Mathematical Building) | Independent work | Scientific and educational fund, scientific periodicals, Wi-Fi access for mobile devices, unlimited access to ELS and database; number of seats - 50. |

**Appendix № 1**

FGBOU VO "BASHKIR STATE UNIVERSITY"

*PHYSICAL AND TECHNICAL INSTITUTE*

**WORK PROGRAM CONTENT**

On Physics discipline

for the 7th semester

daytime form of education

| Type of work | Scope of discipline |
|---|---|
| The total labor intensity of the discipline (ZET / hours) | 4 / 144 |
| Teaching hours for contact work with a teacher: | 37,2 |
| lections | 18 |
| labs | 18 |
| others (group, individual consultation and other types of educational activities involving the work of students with a teacher) (FKR) | 1.2 |
| Teaching hours for independent work of students (SR) | 63 |
| Study hours for preparation for the exam / test / differentiated test (Control) | 43.8 |

Form(s) of control:

seventh semester exam

| No | Theme and content | Form of studying materials: lectures, practical classes, seminars, laboratory work, independent work and labor intensity (in hours) | | | | Basic and additional literature recommended for students (numbers from the list) | Tasks for independent work of students | Form of current progress control (colloquia, tests, computer tests, etc.) |
|---|---|---|---|---|---|---|---|---|
| | | Lc | Pr/Sem | Lb | IW | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | **Module 1: Mechanics. Molecular physics and thermodynamics** | | | | | | | |
| 1. | Basic laws of classical and relativistic mechanics. | 2 | - | 2 | 8 | 1. §1 – §4<br>1. §5 – §15<br>1. §16 – §20<br>1. §140 – §148, §153 – §157 | 2. 1.21; 1.38, 1.68; 1.118; 1.154; 1.175<br>2. 1.297; 1.330<br>1. §34 – §40; §158 – §160<br>2. 3.2; 3.12 | Lab. Work Test№1 |
| 2 | Molecular-kinetic theory of gases. Fundamentals of thermodynamics. real gases. Changes in the aggregate state of matter. | 2 | - | 4 | 12 | 1. §41 – §55<br>1. §56 – §62 | 2. 6.8; 6.10; 6.18; 6.24<br>6.57; 6.61; 6.138; 6.148; 6.158; 6.173 | Lab. Work Test№1 |
| | **Module 2: Electricity and magnetism. Optics. The quantum physics** | | | | | | | |
| 6 | Electric charge. The work of the forces of the electrostatic field. Electric dipole. Electric field in dielectrics. Conductor in an electric field. | 2 | - | 2 | 11 | 1. §77 – §79; §84 – §85; §81 – §83; §87 – §89; §92 – §94; §96 – §97; §99 – §100 | 1. §80; §86; §90; §95; §98; §101<br>2. 2.11 – 2.20; 2.71 – 2.80; 2.121 – 2.130; 2.166 – | Lab. Work Test №2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2. 2.1 – 2.10; 2.59 – 2.70; 2.112 – 2.120; 2.156 – 2.164 | 2.174 | |
| 7 | Constant electric current. Currents in gases and liquids. contact phenomena. Laws of interaction of currents in vacuum. Magnetic dipole. Faraday's law of electromagnetic induction. Alternating current. | 4 | - | 2 | 10 | 1. §109 – §113; §120; §121; §131 – §134; §122 – §125; §146 – §152 2. 2.226 – 2.236; 2.315 – 2.324 | 1. §114; §115; §135; §136; §126; §127; §91; §125; §128 – §130; §161 – §164 2. 2.237 – 2.246; 2.325 – 2.335 | Lab. Work Test №2 |
| 8 | Light interference. Diffraction of light. Polarization of light. Dispersion of light. Scattering of light. | 4 | - | 4 | 14 | 1. §165 – §196 | 1. §§ 169, 174, 182–184, 197–206, 211, 215, | Lab. Work Test №2 |
| 9 | Quantum properties of light. Thermal radiation. The quantum physics. Physics of the atom. | 4 | | 4 | 8 | 1. §208 – §231 | 1. §§ 220–222, 226–228, 232–233 | Lab. Work Test №2 |
| | **Всего часов:** | 18 | - | 18 | 63 | | | |