

## Program: Physical Sciences

This document outlines the scope of themes, which may be included in the Olympiad tests. The themes are grouped by areas and are followed by the list of recommended references in the Russian and English languages.

### Olympiad winner's skill set by subject

To win the Olympiad, you should:

- 1) have a basic understanding of the concepts and laws of physics (listed below), their corollaries, and how they can be applied to explain natural phenomena;
- 2) be able to analyze physical systems and conditions, provide mathematical formulations for typical general physics problems, and apply appropriate mathematical methods to solve them (the problems can be found in the sample test and the problem books references below);
- 3) be able to present problem solutions.

## Content

### Section 1. Mechanics

1. Mechanical motion, trajectory, displacement, velocity and speed, acceleration
2. Tangential and normal acceleration
3. Translational motion of a rigid body
4. Rotation around a fixed axis, angular velocity, angular acceleration
5. Relationship between angular and linear velocities and accelerations
6. Newton's first law, inertial frames of reference
7. Newton's second law
8. Newton's third law
9. The law of universal gravitation
10. Elastic forces
11. Frictional forces
12. Force of gravity and weight
13. Non-inertial reference frames, forces of inertia
14. The centrifugal force of inertia
15. The Coriolis force
16. Kinetic energy
17. Work and power
18. Potential energy in an external force field
19. Potential energy of interaction
20. Total mechanical energy, the law of conservation of energy
21. The momentum of a system of particles, the law of momentum conservation
22. Angular momentum, torque, the law of angular momentum conservation
23. The angular momentum of a rigid body rotating around a fixed axis, the moment of inertia
24. The kinetic energy of a rigid body rotating around a fixed axis
25. The mechanics of an incompressible fluid, flow continuity
26. Bernoulli's equation
27. The movement of bodies in a liquid, added mass
28. Einstein's principle of relativity, constancy of the speed of light
29. Relativistic expressions for the energy and momentum of a particle, momentum and energy conversion

30. Rest energy, mass-energy equivalence
31. Harmonic vibrations
32. Mathematical and physical pendulums
33. Damped oscillations, attenuation coefficient, quality factor
34. Forced vibrations, resonance, resonance curves

## **Section 2. Thermodynamics and molecular physics**

1. The atomic-molecular structure of matter, molecular masses, and sizes
2. Thermodynamic quantities as average values of macroscopic parameters
3. The thermodynamic state of a system, thermodynamic process
4. The internal energy of a system, work, and quantity of heat
5. The first law of thermodynamics
6. Work done by a body upon a change in volume
7. Temperature
8. The equation of state of an ideal gas
9. The internal energy and heat capacity of an ideal gas
10. Polytopic processes
11. The Van der Waals gas, its internal energy, and equations of state
12. The Maxwell distribution
13. The Boltzmann distribution
14. Entropy and its main properties
15. The second law of thermodynamics
16. Statistical interpretation of the second law of thermodynamics
17. The coefficient of performance (COP) of a heat engine
18. A Carnot cycle, the efficiency of a Carnot cycle, Carnot's theorem
19. The features of the crystalline state
20. Classification of crystals
21. Physical types of crystal lattices
22. Heat capacity of crystals, the Dulong-Petit law
23. The structure of liquids
24. Surface tension
25. Pressure under a curved liquid surface
26. Phenomena at liquid-solid interfaces
27. Capillary phenomena
28. Evaporation and condensation
29. Melting and crystallization
30. The Clapeyron-Clausius equation
31. The triple point, phase diagrams

## **Section 3. Electromagnetism**

1. Electric charge, the law of electric charge conservation
2. Coulomb's law
3. Electric field, field strength
4. The field of a point charge
5. The principle of electric field superposition
6. Electric field potential
7. The interaction energy of a system of charges
8. The relation between electric field strength and potential
9. Gauss's theorem for electric field strength

10. The electric field of one and two charged planes
11. The electric field of charged cylindrical and spherical surfaces
12. The electric field of a charged ball
13. Multipole expansion for electric field, dipole and quadrupole approximations
14. Force and torque on a dipole in an external electric field, dipole energy in an external electric field
15. Polarization of dielectrics
16. The electric field inside a dielectric
17. Free, bound, and total charge
18. Electric displacement vector, permittivity
19. Equilibrium of charges on a conductor
20. A conductor in an external electric field
21. Electric capacity
22. Capacitors
23. The capacity of a flat capacitor
24. The energy of a charged capacitor
25. Electric current
26. Continuity equation for electric charge
27. Electromotive force
28. Ohm's law, the resistance of conductors
29. Ohm's law for a non-uniform circuit section
30. Multi-loop circuits, Kirchhoff's rules
31. Power of a current, the Joule-Lenz law
32. Interaction of currents
33. Magnetic field, induction of magnetic field
34. The principle of magnetic field superposition
35. The Biot-Savart law
36. The magnetic field of a line current and a circular current loop
37. The Lorentz force
38. Ampere's law
39. Force exerted on a current circuit in a non-uniform magnetic field
40. Divergence and curl of a magnetic field
41. The magnetic field of a solenoid and a toroid
42. A magnetic dipole, force on a dipole in an external magnetic field
43. The magnetic field in a substance, bound currents, magnetization, magnetic field strength
44. Diamagnetic and paramagnetic materials
45. The phenomenon of electromagnetic induction
46. Lenz's law
47. The electromotive force of induction
48. Foucault's currents
49. Self-induction inductance
50. The EMF of self-induction
51. Solenoid inductance, the energy density of a magnetic field
52. Self-inductance and mutual inductance
53. Vortex electric field
54. Displacement current
55. Electromagnetic field
56. Maxwell's equations in their differential form

#### Section 4. Optics and waves

1. Elastic waves, longitudinal and transverse waves, the wave equation
2. Plane monochromatic waves
3. Standing waves
4. Doppler effect for sound waves
5. Electromagnetic waves
6. The wave equation for an electromagnetic field in a homogeneous isotropic medium
7. The speed of electromagnetic waves
8. A plane monochromatic electromagnetic wave
9. Geometrical optics approximation, light rays, optical path length, Fermat's principle
10. Centered optical system
11. The thin lens
12. Electromagnetic wave interference
13. The interference of plane monochromatic waves, the distance between fringes
14. Temporal coherence
15. Spatial coherence
16. Methods for observing light interference, Fresnel diffraction mirrors, the Fresnel biprism, Lloyd's mirror
17. Thin-film interference
18. Newton's rings
19. Anti-reflective coating
20. The Michelson interferometer
21. Multipath interference
22. Light diffraction, the Huygens-Fresnel principle
23. Fresnel zones
24. Fresnel diffraction on a round hole and a round disk
25. Zone plate
26. Fraunhofer single slit diffraction
27. Diffraction grating
28. Light polarization, natural and polarized light, partially polarized light
29. Polarizers, degree of polarization
30. Reflection and refraction polarization
31. Light reflection and refraction at a flat interface between media, Fresnel equations
32. Total internal reflection, tunnel effect
33. Dispersion of light, a wave packet, the propagation, and spreading of a wave packet in a dispersive medium, phase, and group velocity
34. Light absorption
35. Light scattering, Rayleigh's law, molecular scattering
36. Raman scattering

#### Section 5. Atomic and nuclear physics

1. Heat radiation, the Stefan-Boltzmann law, Wien's law
2. The statistical average of harmonic oscillator energy (classical and quantum expressions), Planck's formula, the Planck constant
3. *Bremsstrahlung*, the short-wavelength boundary of the X-ray *Bremsstrahlung* spectrum
4. Photoelectric effect, Stoletov's experiments
5. Atomic spectra
6. Alpha particle scattering experiments, Rutherford's formula
7. The postulates of Bohr's model

8. The wave properties of matter, the De Broglie hypothesis
9. The quantum-mechanical description of motion
10. The Schrödinger equation, quantization of energy
11. The quantization of angular momentum, spin, the spin of an electron, addition of angular momenta
12. The arrangement of electrons within an atom, the Pauli exclusion principle, shells and subshells, the electronic configuration of the atom, the periodic table
13. The magnetic moment of an atom, orbital and spin magnetic moments, the Bohr magneton
14. Lasers, spontaneous and stimulated emission, Einstein's coefficients, spectral line width, the inverse population of levels
15. Heat capacity of crystals, vibration spectrum of the crystal lattice, the Debye model
16. The composition of an atomic nucleus, atomic number and mass number, isotopes. The nuclear dimensions, mass, binding energy, mass defect
17. Radioactivity, types of radioactive processes, the law of decay
18. Types of interaction and classes of elementary particles, particles, and antiparticles

## Recommended literature

### Section 1. Mechanics

Sources in English	Corresponding topic
1. Chen Min. Berkley Physics Problems with Solutions. pp.1-98. New Delhi: Prentice Hall, 1974. 356 p. URL: <a href="https://archive.org/details/in.ernet.dli.2015.460169">https://archive.org/details/in.ernet.dli.2015.460169</a> (free access)	All the topics of the section, except mechanics of an incompressible fluid and movement of bodies in a liquid.
2. Irodov I.E. Problems in General Physics. Part One: Physical fundamentals of mechanics, pp. 11-74. . Moscow: Mir Publishers, 1988. 395 p. URL: <a href="https://archive.org/details/IrodovProblemsInGeneralPhysics">https://archive.org/details/IrodovProblemsInGeneralPhysics</a> (free access)	All the topics of the section
3. Kittel C., Knight W.D., Ruderman M.A.,Helmholz A.C.,and Moyer B.J. Berkeley Physics Course. Vol. 1: Mechanics. NY: McGraw-Hill, 1973. 426 p. URL: <a href="https://archive.org/details/BerkeleyPhysicsCourse">https://archive.org/details/BerkeleyPhysicsCourse</a> (free access)	All the topics of the section, except mechanics of an incompressible fluid and movement of bodies in a liquid.
4. Savelyev I.V. Physics. A General course. Vol. 1: Mechanics and molecular physics. Part I: The physical fundamentals of mechanics. pp. 7-270. Mir Publishers. Moscow, 1989. 441 p. URL: <a href="https://archive.org/details/savelyev-physics-a-general-course-vol-1-mir/">https://archive.org/details/savelyev-physics-a-general-course-vol-1-mir/</a> (free access)	All the topics of the section
5. R. Shankar. Fundamentals of Physics I. Mechanics, Relativity, and Thermodynamics. pp. 1-351. New Haven and London: Yale University press. 2014. 446 p. URL: <a href="https://archive.org/details/FundamentalsOf">https://archive.org/details/FundamentalsOf</a>	All the topics of the section

Sources in English	Corresponding topic
<a href="#">PhysicsMechanicsRelativityAndThermodynamics</a> (free access)	

Sources in Russian	Corresponding topic
<p>1. Иродов И.Е. Задачи по общей физике. Ч.1: Физические основы механики, стр. 7-79, и Ч.3: Колебания и волны, стр. 152-167 . М: Лаборатория знаний, 2021. 434 с.</p> <p>URL: <a href="https://www.litres.ru/igor-irodov/zadachi-po-obschey-fizike-uchebnoe-posobie-dlya-vuzov/">https://www.litres.ru/igor-irodov/zadachi-po-obschey-fizike-uchebnoe-posobie-dlya-vuzov/</a> (subscription access)</p> <p>or <a href="https://avidreaders.ru/book/zadachi-po-obschey-fizike-uchebnoe-posobie.html">https://avidreaders.ru/book/zadachi-po-obschey-fizike-uchebnoe-posobie.html</a> (subscription access)</p> <p>Earlier editions can be found freely available through the links: <a href="https://techlibrary.ru/">https://techlibrary.ru/</a> and <a href="https://nat.uch-lit.ru/fizika/irodov-i-e-zadachi-po-obshhey-fizike-1-e-izdanie-onlayn">https://nat.uch-lit.ru/fizika/irodov-i-e-zadachi-po-obshhey-fizike-1-e-izdanie-onlayn</a></p>	All the topics of the section
<p>2. Иродов И.Е. Механика. Основные законы. М: Лаборатория знаний, 2021.312 с.</p> <p>URL: <a href="https://www.litres.ru/igor-irodov/mehanika-osnovnye-zakony-2/">https://www.litres.ru/igor-irodov/mehanika-osnovnye-zakony-2/</a> (subscription access)</p> <p>An earlier edition can be found freely available through the link: <a href="https://nat.uch-lit.ru/fizika/irodov-i-e-osnovnyie-zakonyi-mehaniki-onlayn">https://nat.uch-lit.ru/fizika/irodov-i-e-osnovnyie-zakonyi-mehaniki-onlayn</a></p>	All the topics of the section
<p>3. Савельев И.В.. Курс общей физики (в 5-и томах). Т.1: Механика. СПб: Лань, 2022. 340 с.</p> <p>URL: <a href="https://www.litres.ru/i-v-savelev/kurs-obschey-fiziki-v-5-t-tom-1-mehanika-66009137/">https://www.litres.ru/i-v-savelev/kurs-obschey-fiziki-v-5-t-tom-1-mehanika-66009137/</a> (subscription access)</p> <p>or <a href="https://avidreaders.ru/book/kurs-obschey-fiziki-v-5-t.html">https://avidreaders.ru/book/kurs-obschey-fiziki-v-5-t.html</a> (subscription access)</p> <p>Earlier editions can be found freely available through the links: <a href="https://obuchalka.org/20210301129695/kurs-obschei-fiziki-tom-1-mehanika-kolebaniya-i-volni-molekulyarnaya-fizika-savelev-i-v-1970.html">https://obuchalka.org/20210301129695/kurs-obschei-fiziki-tom-1-mehanika-kolebaniya-i-volni-molekulyarnaya-fizika-savelev-i-v-1970.html</a> and <a href="https://techlibrary.ru/">https://techlibrary.ru/</a></p>	All the topics of the section
<p>4. Савельев И.В. Сборник вопросов и задач по общей физике. Ч.1: Физические основы механики, стр. 14-70. СПб: Лань, 2022. 292 с.</p>	All the topics of the section

Sources in Russian	Corresponding topic
<p>URL: <a href="https://www.litres.ru/i-v-savelev/sbornik-voprosov-i-zadach-po-obschey-fizike-66005701/">https://www.litres.ru/i-v-savelev/sbornik-voprosov-i-zadach-po-obschey-fizike-66005701/</a> (subscription access)</p> <p>or</p> <p><a href="https://avidreaders.ru/book/sbornik-voprosov-i-zadach-po-obschey-2.html">https://avidreaders.ru/book/sbornik-voprosov-i-zadach-po-obschey-2.html</a> (subscription access)</p> <p>An earlier edition can be found freely available through the link: <a href="https://techlibrary.ru/">https://techlibrary.ru/</a></p>	
<p>5. Сивухин Д.В. Общий курс физики (в 5 томах). Т.1: Механика. М: Физматлит, 2013. 560 с.</p> <p>URL:<a href="https://e.fmlib.ru/uchebnaya-literatura/obschij-kurs-fiziki-tom-1-mekhanika/">https://e.fmlib.ru/uchebnaya-literatura/obschij-kurs-fiziki-tom-1-mekhanika/</a> (subscription access)</p> <p>Earlier editions can be found freely available through the links: <a href="https://obuchalka.org/20210302129745/obschii-kurs-fiziki-tom-1-mehanika-sivuhin-d-v-2005.html">https://obuchalka.org/20210302129745/obschii-kurs-fiziki-tom-1-mehanika-sivuhin-d-v-2005.html</a> and <a href="https://techlibrary.ru/">https://techlibrary.ru/</a></p>	<p>All the topics of the section, except relativistic mechanics (the Einstein's principle of relativity; the constancy of the speed of light; the relativistic expressions for the energy and momentum of a particle; momentum and energy conversion; rest energy; mass-energy equivalence).</p>

## Section 2. Thermodynamics and molecular physics

Sources in English	Corresponding topic
<p>1. Chen Min. Berkley Physics Problems with Solutions. pp. 182-262. New Delhi: Prentice Hall, 1974. 356 p</p> <p>URL:<a href="https://archive.org/details/in.ernet.dli.2015.460169/">https://archive.org/details/in.ernet.dli.2015.460169/</a> (free access)</p>	<p>All the topics of the section</p>
<p>2. Irodov I. E. Problems in General Physics, Part Two: Thermodynamics and molecular physics. pp. 75-104. Mir Publishers. Moscow, 1988. 395 p.</p> <p>URL:<a href="https://archive.org/details/IrodovProblemsInGeneralPhysics">https://archive.org/details/IrodovProblemsInGeneralPhysics</a> (free access)</p>	<p>All the topics of the section</p>
<p>3. Reif. F. Berkeley Physics Course, Vol. 5: Statistical Physics. NY: McGraw-Hill, 1967. 398 p.</p> <p>URL:<a href="https://archive.org/details/berkeleyphysicsc05kitt">https://archive.org/details/berkeleyphysicsc05kitt</a> (free access)</p>	<p>The atomic-molecular structure of matter. Molecular masses and sizes; thermodynamic quantities as average values of macroscopic parameters; the thermodynamic state of a system, thermodynamic process; internal energy of a system, work, and quantity of heat; the first law of thermodynamics; work done by a body upon change in volume; the average energy of translational motion of molecules; temperature and its physical meaning; temperature; equation of state of an ideal gas; internal energy and heat capacity of an ideal gas; polytropic</p>

Sources in English	Corresponding topic
	processes; the Maxwell distribution; the Boltzmann distribution; entropy and its main properties; the second law of thermodynamics; statistical interpretation of the second law of thermodynamics.
<p>4. Savelyev I.V. Physics. A General course. Vol. 1: Mechanics and molecular physics. Part II: Molecular physics and thermodynamics. pp. 271-436. Mir Publishers. Moscow, 1989. 441 p.</p> <p>URL: <a href="https://archive.org/details/savelyev-physics-a-general-course-vol-1-mir/">https://archive.org/details/savelyev-physics-a-general-course-vol-1-mir/</a> (free access)</p>	All the topics of the section
<p>5. Shankar R. Fundamentals of Physics I. Mechanics, Relativity, and Thermodynamics. pp. 352-442. New Haven and London: Yale University press. 2014. 446 p.</p> <p>URL: <a href="https://archive.org/details/FundamentalsOfPhysicsMechanicsRelativityAndThermodynamics">https://archive.org/details/FundamentalsOfPhysicsMechanicsRelativityAndThermodynamics</a> (free access)</p>	The atomic-molecular structure of matter; molecular masses and sizes; thermodynamic quantities as average values of macroscopic parameters; thermodynamic state of a system, thermodynamic process; the internal energy of a system, work, and quantity of heat; the first law of thermodynamics; work done by a body upon change in volume; the average energy of translational motion of molecules; temperature and its physical meaning; temperature; equation of state of an ideal gas; internal energy and heat capacity of an ideal gas; polytropic processes; entropy and its main properties; the second law of thermodynamics; statistical interpretation of the second law of thermodynamics

Sources in Russian	Corresponding topic
<p>1. Иродов И.Е.. Задачи по общей физике. Ч.6: Физика макросистем. стр. 287-335. М: Лаборатория знаний, 2021. 434 с.</p> <p>URL: <a href="https://www.litres.ru/igor-irodov/zadachi-po-obschey-fizike-uchebnoe-posobie-dlya-vuzov/">https://www.litres.ru/igor-irodov/zadachi-po-obschey-fizike-uchebnoe-posobie-dlya-vuzov/</a> (subscription access)</p> <p>or</p> <p><a href="https://avidreaders.ru/book/zadachi-po-obschey-fizike-uchebnoe-posobie.html">https://avidreaders.ru/book/zadachi-po-obschey-fizike-uchebnoe-posobie.html</a> (subscription access)</p> <p>Earlier editions can be found freely available through the links:</p> <p><a href="https://techlibrary.ru/">https://techlibrary.ru/</a></p> <p>and</p> <p><a href="https://nat.uch-lit.ru/fizika/irodov-i-e-zadachi-po-">https://nat.uch-lit.ru/fizika/irodov-i-e-zadachi-po-</a></p>	All the topics of the section



Sources in Russian	Corresponding topic
<p><a href="#">obshhey-fizike-1-e-izdanie-onlayn</a></p> <p>2. Иродов И.Е. Физика макросистем. Основные законы. М: Лаборатория знаний, 2020. 210 с. URL: <a href="https://www.litres.ru/igor-irodov/fizika-makrosistem-osnovnye-zakony-uchebnoe-posobie/">https://www.litres.ru/igor-irodov/fizika-makrosistem-osnovnye-zakony-uchebnoe-posobie/</a> (subscription access) An earlier edition can be found freely available through the link: <a href="https://nat.uch-lit.ru/fizika/irodov-i-e-fizika-makrosistem-osnovnyie-zakonyi-onlayn">https://nat.uch-lit.ru/fizika/irodov-i-e-fizika-makrosistem-osnovnyie-zakonyi-onlayn</a></p>	All the topics of the section
<p>3. Савельев И.В. Курс общей физики (в 5-и томах) Т.3: Молекулярная физика и термодинамика. СПб: Лань, 2022. 212 с. URL: <a href="https://www.litres.ru/i-v-savelev/kurs-obschey-fiziki-v-5-i-tt-tom-3-molekulyarnaya-fiz-65998546/">https://www.litres.ru/i-v-savelev/kurs-obschey-fiziki-v-5-i-tt-tom-3-molekulyarnaya-fiz-65998546/</a> (subscription access) or <a href="https://avidreaders.ru/book/kurs-obschey-fiziki-v-5-i-1.html">https://avidreaders.ru/book/kurs-obschey-fiziki-v-5-i-1.html</a> (subscription access) Earlier editions can be found freely available through the links: <a href="https://obuchalka.org/20210301129695/kurs-obschei-fiziki-tom-1-mehanika-kolebaniya-i-volni-molekulyarnaya-fizika-savelev-i-v-1970.html">https://obuchalka.org/20210301129695/kurs-obschei-fiziki-tom-1-mehanika-kolebaniya-i-volni-molekulyarnaya-fizika-savelev-i-v-1970.html</a> ( and <a href="https://techlibrary.ru/">https://techlibrary.ru/</a></p>	All the topics of the section
<p>4. Савельев И. В. Сборник вопросов и задач по общей физике. Ч.2: Молекулярная физика и термодинамика, стр. 71-102. СПб: Лань, 2022. 292 с. URL: <a href="https://www.litres.ru/i-v-savelev/sbornik-voprosov-i-zadach-po-obschey-fizike-66005701/">https://www.litres.ru/i-v-savelev/sbornik-voprosov-i-zadach-po-obschey-fizike-66005701/</a> (subscription access) or <a href="https://avidreaders.ru/book/sbornik-voprosov-i-zadach-po-obschey-2.html">https://avidreaders.ru/book/sbornik-voprosov-i-zadach-po-obschey-2.html</a> (subscription access) An earlier edition can be found freely available through the link: <a href="https://techlibrary.ru/">https://techlibrary.ru/</a></p>	All the topics of the section
<p>5. Сивухин Д.В. Общий курс физики (в 5 томах). Т. 2: Термодинамика и молекулярная физика. М: Физматлит, 2013. 544 с. URL: <a href="https://e.fmlib.ru/uchebnaya-literatura/obschij-kurs-fiziki-tom-2-termodinamika-i-molekulyarnaya-fizika/">https://e.fmlib.ru/uchebnaya-literatura/obschij-kurs-fiziki-tom-2-termodinamika-i-molekulyarnaya-fizika/</a> (subscription access) Earlier editions can be found freely available through the links: <a href="https://obuchalka.org/20210302129748/obschii-">https://obuchalka.org/20210302129748/obschii-</a></p>	All the topics of the section

Sources in Russian	Corresponding topic
<a href="http://kurs-fiziki-tom-2-termodinamika-i-molekulyarnaya-fizika-sivuhin-d-v-2005.html">kurs-fiziki-tom-2-termodinamika-i-molekulyarnaya-fizika-sivuhin-d-v-2005.html</a> and <a href="https://techlibrary.ru/">https://techlibrary.ru/</a>	

### Section 3. Electromagnetism

Sources in English	Corresponding topic
1. Chen Min. Berkley Physics Problems with Solutions. pp.99-181. New Delhi: Prentice Hall, 1974. 356 p URL: <a href="https://archive.org/details/in.ernet.dli.2015.460169/">https://archive.org/details/in.ernet.dli.2015.460169/</a> (free access)	All the topics of the section, except the multipole expansion for an electric field, dipole and quadrupole approximations
2. Irodov I. E. Problems in General Physics. Part Three: Electrodynamics. pp.105-165.. Mir Publishers. Moscow, 1988. 395 p. URL: <a href="https://archive.org/details/IrodovProblemsInGeneralPhysics">https://archive.org/details/IrodovProblemsInGeneralPhysics</a> (free access)	All the topics of the section, except the multipole expansion for electric field, dipole and quadrupole approximations
3. Purcell E.M. Berkeley Physics Course, Vol. 2. Electricity and Magnetism. NY: McGraw-Hill Book Comp., 1965. 463 p. URL: <a href="https://archive.org/details/berkeleyphysicsc02kitt">https://archive.org/details/berkeleyphysicsc02kitt</a> (free access)	All the topics of the section
4. Savelyev I.V. Physics. A General course. Vol. 2: Electricity and magnetism, waves, optics. Part I: Electricity and magnetism. pp. 11-317. Mir Publishers. Moscow, 1989. 507 p. URL: <a href="https://archive.org/details/SavelyevPhysicsGeneralCourseVol2">https://archive.org/details/SavelyevPhysicsGeneralCourseVol2</a> (free access)	All the topics of the section
5. Shankar R. Fundamentals of Physics II. Electromagnetism, Optics, and Quantum Mechanics. Chapters 1-13. Yale University press, New Haven and London, 2016. 557 p. URL: <a href="https://archive.org/details/FundamentalsOfPhysicsIIElectromagnetismOpticsAndQuantumMechanics">https://archive.org/details/FundamentalsOfPhysicsIIElectromagnetismOpticsAndQuantumMechanics</a> (free access)	All the topics of the section, except the multipole expansion for an electric field, dipole and quadrupole approximations

Sources in Russian	Corresponding topic
1. Иродов И.Е. Задачи по общей физике. Ч.2: Электромагнетизм. стр. 80-151. М: Лаборатория знаний, 2021. 434 с. URL: <a href="https://www.litres.ru/igor-irodov/zadachi-po-obschey-fizike-uchebnoe-posobie-dlya-vuzov/">https://www.litres.ru/igor-irodov/zadachi-po-obschey-fizike-uchebnoe-posobie-dlya-vuzov/</a> (subscription access) or <a href="https://avidreaders.ru/book/zadachi-po-obschey-fizike-uchebnoe-posobie.html">https://avidreaders.ru/book/zadachi-po-obschey-fizike-uchebnoe-posobie.html</a> (subscription access) Earlier editions can be found freely available	All the topics of the section, except the multipole expansion for an electric field, dipole and quadrupole approximations

Sources in Russian	Corresponding topic
through the links: <a href="https://nat.uch-lit.ru/fizika/irodov-i-e-zadachi-po-obshhey-fizike-1-e-izdanie-onlayn">https://nat.uch-lit.ru/fizika/irodov-i-e-zadachi-po-obshhey-fizike-1-e-izdanie-onlayn</a> and <a href="https://techlibrary.ru/">https://techlibrary.ru/</a>	
2. Иродов И.Е. Электричوماгнетизм. Основные законы. М: Лаборатория знаний, 2021. 322с. URL: <a href="https://www.litres.ru/igor-irodov/elektromagnetizm-osnovnyye-zakony/">https://www.litres.ru/igor-irodov/elektromagnetizm-osnovnyye-zakony/</a> (subscription access) An earlier edition can be found freely available through the link: <a href="https://nat.uch-lit.ru/fizika/irodov-i-e-osnovnyie-zakonyi-mehaniki-onlayn">https://nat.uch-lit.ru/fizika/irodov-i-e-osnovnyie-zakonyi-mehaniki-onlayn</a>	All the topics of the section
3. Савельев И. В. Сборник вопросов и задач по общей физике. Ч.3: Электричество и магнетизм, стр. 103-146. СПб: Лань, 2022. 292 с. URL: <a href="https://www.litres.ru/i-v-savelev/sbornik-voprosov-i-zadach-po-obschey-fizike-66005701/">https://www.litres.ru/i-v-savelev/sbornik-voprosov-i-zadach-po-obschey-fizike-66005701/</a> (subscription access) or <a href="https://avidreaders.ru/book/sbornik-voprosov-i-zadach-po-obschey-2.html">https://avidreaders.ru/book/sbornik-voprosov-i-zadach-po-obschey-2.html</a> (subscription access) An earlier edition can be found freely available through the link: <a href="https://techlibrary.ru/">https://techlibrary.ru/</a>	All the topics of the section, except the multipole expansion for an electric field, dipole and quadrupole approximations
4. Савельев И.В. Курс общей физики (в 5-и томах). Т.2: Электричество и магнетизм. СПб: Лань, 2022. 352 с. <a href="https://www.litres.ru/i-v-savelev/kurs-obschey-fiziki-v-5-i-tt-tom-2-elektrichestvo-i-m-65998542/">https://www.litres.ru/i-v-savelev/kurs-obschey-fiziki-v-5-i-tt-tom-2-elektrichestvo-i-m-65998542/</a> (subscription access) or <a href="https://avidreaders.ru/book/kurs-obschey-fiziki-v-5-i.html">https://avidreaders.ru/book/kurs-obschey-fiziki-v-5-i.html</a> (subscription access) Earlier editions can be found freely available through the links:; <a href="https://obuchalka.org/20210301129702/kurs-obschei-fiziki-tom-2-elektrichestvo-savelev-i-v-1970.html">https://obuchalka.org/20210301129702/kurs-obschei-fiziki-tom-2-elektrichestvo-savelev-i-v-1970.html</a> and <a href="https://techlibrary.ru/">https://techlibrary.ru/</a>	All the topics of the section, except the multipole expansion for an electric field, dipole and quadrupole approximations
5. Сивухин Д.В. Общий курс физики (в 5 томах). Т. 3: Электричеств. М: Физматлит, 2015. 656 с. URL: <a href="https://e.fmlib.ru/uchebnaya-literatura/obschij-kurs-fiziki-tom-3-elektrichestvo/">https://e.fmlib.ru/uchebnaya-literatura/obschij-kurs-fiziki-tom-3-elektrichestvo/</a> (subscription access)	All the topics of the section

Sources in Russian	Corresponding topic
<p>Earlier editions can be found freely available through the links:</p> <p><a href="https://obuchalka.org/20210302129751/obschii-kurs-fiziki-tom-3-elektrichestvo-sivuhin-d-v-2009.html">https://obuchalka.org/20210302129751/obschii-kurs-fiziki-tom-3-elektrichestvo-sivuhin-d-v-2009.html</a></p> <p>and</p> <p><a href="https://techlibrary.ru/">https://techlibrary.ru/</a></p>	

#### Section 4. Optics and waves

Sources in English	Corresponding topic
<p>1. Chen Min. Berkley Physics Problems with Solutions. pp.182-262. New Delhi: Prentice Hall, 1974. 356 p</p> <p>URL:<a href="https://archive.org/details/in.ernet.dli.2015.460169/">https://archive.org/details/in.ernet.dli.2015.460169/</a> (free access)</p>	All the topics of the section
<p>2. Crawford F.S. Berkeley Physics Course, Vol. 3: Waves. NY: McGraw-Hill Book Comp., 1968. 625 p.</p> <p>URL:<a href="https://bib.convdocs.org/v38297/crawford_f.s._berkeley_physics_course._vol._3._waves">https://bib.convdocs.org/v38297/crawford_f.s._berkeley_physics_course._vol._3._waves</a> (free access)</p>	All the topics of the section
<p>3. Irodov I. E. Problems in General Physics. Part Four: Oscillations and waves, and Part Five: Optics. pp. 166-245. Mir Publishers. Moscow, 1988. 395 p.</p> <p>URL:<a href="https://archive.org/details/IrodovProblemsInGeneralPhysics">https://archive.org/details/IrodovProblemsInGeneralPhysics</a> (free access)</p>	All the topics of the section
<p>4. Savelyev I.V. Physics. A General course. Vol. 2: Electricity and magnetism, waves, optics. Part II: Waves and Part III: Optics. pp. 275-484. Mir Publishers. Moscow, 1989. 507 p.</p> <p>URL:<a href="https://archive.org/details/SavelyevPhysicsGeneralCourseVol2">https://archive.org/details/SavelyevPhysicsGeneralCourseVol2</a> (free access)</p>	All the topics of the section
<p>5. Shankar R. Fundamentals of Physics II. Electromagnetism, Optics, and Quantum Mechanics. Chapters 14-18. Yale University press, New Haven and London, 2016. 557 p.</p> <p>URL:<a href="https://archive.org/details/FundamentalsOfPhysicsIIElectromagnetismOpticsAndQuantumMechanics">https://archive.org/details/FundamentalsOfPhysicsIIElectromagnetismOpticsAndQuantumMechanics</a> (free access)</p>	All the topics of the section

Sources in Russian	Corresponding topic
<p>1. Иродов И.Е. Волновые процессы. Основные законы. М: Лаборатория знаний, 2020.266 с.</p> <p>URL: <a href="https://www.litres.ru/igor-irodov/volnovye-processy-osnovnye-zakony/">https://www.litres.ru/igor-irodov/volnovye-processy-osnovnye-zakony/</a> (subscription access)</p> <p>An earlier edition can be found freely available</p>	All the topics of the section

Sources in Russian	Corresponding topic
through the link: <a href="https://nat.uch-lit.ru/fizika/irodov-i-e-volnovyie-protsessyi-osnovnyie-zakonyi-onlayn">https://nat.uch-lit.ru/fizika/irodov-i-e-volnovyie-protsessyi-osnovnyie-zakonyi-onlayn</a>	
2. Иродов И.Е. Задачи по общей физике. Ч.3: Колебания и волны и Ч.4: Оптика, стр. 152-242. М: Лаборатория знаний, 2021. 434 с. URL: <a href="https://www.litres.ru/igor-irodov/zadachi-po-obschey-fizike-uchebnoe-posobie-dlya-vuzov/">https://www.litres.ru/igor-irodov/zadachi-po-obschey-fizike-uchebnoe-posobie-dlya-vuzov/</a> (subscription access) or <a href="https://avidreaders.ru/book/zadachi-po-obschey-fizike-uchebnoe-posobie.html">https://avidreaders.ru/book/zadachi-po-obschey-fizike-uchebnoe-posobie.html</a> (subscription access) Earlier editions can be found freely available through the links: <a href="https://nat.uch-lit.ru/fizika/irodov-i-e-zadachi-po-obshhey-fizike-1-e-izdanie-onlayn">https://nat.uch-lit.ru/fizika/irodov-i-e-zadachi-po-obshhey-fizike-1-e-izdanie-onlayn</a> and <a href="https://techlibrary.ru/">https://techlibrary.ru/</a>	All the topics of the section
3. Савельев И.В. Курс общей физики (в 5 томах) Т.4: Оптика. Волны. СПб: Лань, 2022. 252 с. URL: <a href="https://www.litres.ru/i-v-savelev/kurs-obschey-fiziki-v-5-i-tt-tom-4-volny-optika-65998550/">https://www.litres.ru/i-v-savelev/kurs-obschey-fiziki-v-5-i-tt-tom-4-volny-optika-65998550/</a> (subscription access) or <a href="https://avidreaders.ru/book/kurs-obschey-fiziki-v-5-i-2.html">https://avidreaders.ru/book/kurs-obschey-fiziki-v-5-i-2.html</a> (subscription access) Earlier editions can be found freely available through the links: <a href="https://obuchalka.org/20210301129704/kurs-obschei-fiziki-tom-3-optika-atomnaya-fizika-fizika-atomnogo-yadra-i-elementarnih-chastic-savelev-i-v-1970.html">https://obuchalka.org/20210301129704/kurs-obschei-fiziki-tom-3-optika-atomnaya-fizika-fizika-atomnogo-yadra-i-elementarnih-chastic-savelev-i-v-1970.html</a> and <a href="https://techlibrary.ru/">https://techlibrary.ru/</a>	All the topics of the section
4. Савельев И.В. Сборник вопросов и задач по общей физике. Ч.4: Волны и Ч.5: Оптика, стр. 147-190. СПб: Лань, 2022. 292 с. URL: <a href="https://www.litres.ru/i-v-savelev/sbornik-voprosov-i-zadach-po-obschey-fizike-66005701/">https://www.litres.ru/i-v-savelev/sbornik-voprosov-i-zadach-po-obschey-fizike-66005701/</a> (subscription access) or <a href="https://avidreaders.ru/book/sbornik-voprosov-i-zadach-po-obschey-2.html">https://avidreaders.ru/book/sbornik-voprosov-i-zadach-po-obschey-2.html</a> (subscription access) An earlier edition can be found freely available through the link: <a href="https://techlibrary.ru/">https://techlibrary.ru/</a>	All the topics of the section
5. Сивухин Д.В. Общий курс физики (в 5 томах). Т. 4: Оптика. М: Физматлит, 2017. 792 с.	All the topics of the section

Sources in Russian	Corresponding topic
URL: <a href="https://e.fmlib.ru/uchebnyaya-literatura/obschij-kurs-fiziki-tom-4-optika/">https://e.fmlib.ru/uchebnyaya-literatura/obschij-kurs-fiziki-tom-4-optika/</a> (subscription access) Earlier editions can be found freely available through the links: <a href="https://obuchalka.org/20210302129752/obschii-kurs-fiziki-tom-4-optika-sivuhin-d-v-2005.html">https://obuchalka.org/20210302129752/obschii-kurs-fiziki-tom-4-optika-sivuhin-d-v-2005.html</a> and <a href="https://techlibrary.ru/">https://techlibrary.ru/</a>	

### Section 5. Atomic and nuclear physics

Sources in English	Corresponding topic
1. Chen Min. Berkley Physics Problems with Solutions. pp.263-350. New Delhi: Prentice Hall, 1974. 356 p URL: <a href="https://archive.org/details/in.ernet.dli.2015.460169/">https://archive.org/details/in.ernet.dli.2015.460169/</a> (free access)	All the topics of the section
2. Irodov I. E. Problems in General Physics, Part Six: Atomic and nuclear physics. pp. 246-279. Mir Publishers. Moscow, 1988. 395 p. URL: <a href="https://archive.org/details/IrodovProblemsInGeneralPhysics">https://archive.org/details/IrodovProblemsInGeneralPhysics</a> (free access)	All the topics of the section
3. Savelyev I.V. Physics. A General course. Vol. 3: Quantum Optics, Atomic Physics, Solid State Physics, Physics of the Atomic Nucleus and Elementary Particles. Mir Publishers. Moscow, 1989. 317 p. URL: <a href="https://archive.org/details/SavelyevPhysicsGeneralCourseVol3/">https://archive.org/details/SavelyevPhysicsGeneralCourseVol3/</a> (free access)	All the topics of the section
4. Shankar R. Fundamentals of Physics II. Electromagnetism, Optics, and Quantum Mechanics. Chapters 19-24. Yale University press, New Haven and London, 2016. 557 p. URL: <a href="https://archive.org/details/FundamentalsOfPhysicsIIElectromagnetismOpticsAndQuantumMechanics">https://archive.org/details/FundamentalsOfPhysicsIIElectromagnetismOpticsAndQuantumMechanics</a> (free access)	All the topics of the section
5. Wichmann E.H. Berkeley Physics Course, Vol. 4: Quantum physics. NY: McGraw-Hill, 1971. 440 p. URL: <a href="https://archive.org/details/QuantumPhysicsBerkeleyPhysicsCourseVolume4">https://archive.org/details/QuantumPhysicsBerkeleyPhysicsCourseVolume4</a> (free access)	All the topics of the section

Sources in Russian	Corresponding topic
1. Иродов И.Е. Задачи по общей физике. Ч.5: Квантовая физика. стр.243-286. М: Лаборатория знаний, 2021. 434 с. URL: <a href="https://www.litres.ru/igor-irodov/zadachi-">https://www.litres.ru/igor-irodov/zadachi-</a>	All the topics of the section

Sources in Russian	Corresponding topic
<p><a href="#">po-obschey-fizike-uchebnoe-posobie-dlya-vuzov/</a> (subscription access)</p> <p>or</p> <p><a href="https://avidreaders.ru/book/zadachi-po-obschey-fizike-uchebnoe-posobie.html">https://avidreaders.ru/book/zadachi-po-obschey-fizike-uchebnoe-posobie.html</a> (subscription access)</p> <p>Earlier editions can be found freely available through the links:</p> <p><a href="https://nat.uch-lit.ru/fizika/irodov-i-e-zadachi-po-obshhey-fizike-1-e-izdanie-onlayn">https://nat.uch-lit.ru/fizika/irodov-i-e-zadachi-po-obshhey-fizike-1-e-izdanie-onlayn</a></p> <p>and</p> <p><a href="https://techlibrary.ru/">https://techlibrary.ru/</a></p>	
<p>2. Иродов И.Е. Квантовая физика. Основные законы. М: Лаборатория знаний, 2021. 261 с.</p> <p>URL: <a href="https://www.litres.ru/igor-irodov/kvantovaya-fizika-osnovnye-zakony-uchebnoe-posobie-dlya-vuzov/">https://www.litres.ru/igor-irodov/kvantovaya-fizika-osnovnye-zakony-uchebnoe-posobie-dlya-vuzov/</a> (subscription access)</p> <p>An earlier edition can be found freely available through the link:</p> <p><a href="https://nat.uch-lit.ru/fizika/irodov-i-e-kvantovaya-fizika-osnovnyie-zakonyi">https://nat.uch-lit.ru/fizika/irodov-i-e-kvantovaya-fizika-osnovnyie-zakonyi</a></p>	All the topics of the section
<p>3. Савельев И.В. Курс общей физики (в 5-и томах). Т.5: Квантовая оптика. Атомная физика. Физика твердого тела. Физика атомного ядра и элементарных частиц. СПб: Лань,, 2021. 384 с.</p> <p>URL: <a href="https://www.litres.ru/i-v-savelev/kurs-obschey-fiziki-v-5-i-tt-tom-5-kvantovaya-optika-65998554/">https://www.litres.ru/i-v-savelev/kurs-obschey-fiziki-v-5-i-tt-tom-5-kvantovaya-optika-65998554/</a> (subscription access)</p> <p>or</p> <p><a href="https://avidreaders.ru/book/kurs-obschey-fiziki-v-5-i-3.html">https://avidreaders.ru/book/kurs-obschey-fiziki-v-5-i-3.html</a> (subscription access)</p> <p>Earlier editions can be found freely available through the links:</p> <p><a href="https://obuchalka.org/20210301129704/kurs-obschei-fiziki-tom-3-optika-atomnaya-fizika-fizika-atomnogo-yadra-i-elementarnih-chastic-savelev-i-v-1970.html">https://obuchalka.org/20210301129704/kurs-obschei-fiziki-tom-3-optika-atomnaya-fizika-fizika-atomnogo-yadra-i-elementarnih-chastic-savelev-i-v-1970.html</a></p> <p>and</p> <p><a href="https://techlibrary.ru/">https://techlibrary.ru/</a></p>	All the topics of the section
<p>4. Савельев И. В. Сборник вопросов и задач по общей физике. Ч.6: Атомная физика, стр. 191-216. СПб: Лань, 2022. 292 с.</p> <p>URL: <a href="https://www.litres.ru/i-v-savelev/sbornik-voprosov-i-zadach-po-obschey-fizike-66005701/">https://www.litres.ru/i-v-savelev/sbornik-voprosov-i-zadach-po-obschey-fizike-66005701/</a> (subscription access)</p> <p>or</p> <p><a href="https://avidreaders.ru/book/sbornik-voprosov-i-zadach-po-obschey-2.html">https://avidreaders.ru/book/sbornik-voprosov-i-zadach-po-obschey-2.html</a> (subscription access)</p> <p>An earlier edition can be found freely available</p>	All the topics of the section

Sources in Russian	Corresponding topic
through the link: <a href="https://techlibrary.ru/">https://techlibrary.ru/</a>	
<p>5. Сивухин Д.В. Общий курс физики (в 5 томах). Т. 5:Атомная и ядерная физика. М: Физматлит, 2008. 784 с.</p> <p>URL: <a href="https://e.fmlib.ru/uchebnaya-literatura/obschij-kurs-fiziki-tom-5-atomnaya-i-yadernaya-fizika/">https://e.fmlib.ru/uchebnaya-literatura/obschij-kurs-fiziki-tom-5-atomnaya-i-yadernaya-fizika/</a> (subscription access)</p> <p>Earlier editions can be found freely available through the links:  <a href="https://obuchalka.org/20210302129753/obschii-kurs-fiziki-tom-5-atomnaya-i-yadernaya-fizika-sivuhin-d-v-2002.html">https://obuchalka.org/20210302129753/obschii-kurs-fiziki-tom-5-atomnaya-i-yadernaya-fizika-sivuhin-d-v-2002.html</a>  and  <a href="https://techlibrary.ru/">https://techlibrary.ru/</a></p>	All the topics of the section

## Recommended online courses

### Section 1. Mechanics

- How Things Work: An Introduction to Physics (Coursera)  
URL: <https://ru.coursera.org/learn/how-things-work>
- Mechanics, Part 1 (EdX)  
URL: <https://www.edx.org/course/introduction-to-mechanics-part-1>
- Mechanics, Part2 (EdX)  
URL: <https://www.edx.org/course/mechanics-part-2-2>
- Introduction to Mechanics (Coursera)  
URL: <https://ru.coursera.org/specializations/introduction-to-mechanics>
- Physics (Stepik)  
URL: <https://stepik.org/48615>
- Understanding Einstein: The special theory of relativity (Coursera)  
URL: <https://ru.coursera.org/learn/einstein-relativity>

### Section 2. Thermodynamics and molecular physics

- Fundamentals of Macroscopic and Microscopic Thermodynamics (Coursera)  
URL: <https://www.coursera.org/learn/macroscopic-microscopic-thermodynamics>
- Ideal Gases (Coursera)  
URL: <https://www.coursera.org/learn/ideal-gases>
- Introduction to Thermodynamics: Transferring Energy from Here to There (Coursera)  
URL: <https://www.coursera.org/learn/thermodynamics-intro>
- Physics (Stepik)  
URL: <https://stepik.org/48615>
- Thermodynamics (EdX)  
URL: <https://www.edx.org/course/thermodynamics>

### Section 3. Electromagnetism

- Physics (Stepik)  
URL: <https://stepik.org/48615>



2. Electrodynamics: An Introduction (Coursera)  
URL: <https://www.coursera.org/learn/electrodynamics-introduction>
3. Electrodynamics: Analysis of Electric Fields (Coursera)  
URL: <https://www.coursera.org/learn/electrodynamics-analysis-of-electric-fields>
4. Electrodynamics: Electric and Magnetic Fields (Coursera)  
URL: <https://www.coursera.org/learn/electrodynamics-electric-magnetic-fields>
5. Electrodynamics: In-depth Solutions for Maxwell's Equations (Coursera)  
URL: <https://www.coursera.org/learn/electrodynamics-solutions-maxwells-equations>

#### Section 4. Optics and waves

1. Optics and Modern Physics (EdX)  
URL: <https://www.edx.org/course/ap-physics-2-part-3-optics-and-modern-physics>
2. Optical physics – Wave optics (Udemy)  
URL: <https://www.udemy.com/course/optical-physics-wave-optics/>
3. Waves and light (Brilliant)  
URL: <https://brilliant.org/courses/waves-and-light/>
4. Vibrations and Waves (Class central from CalTech)  
URL: <https://www.classcentral.com/course/youtube-ph2a-vibrations-and-waves-48197>
5. Oscillations and Waves (Class central from NPTEL)  
URL: <https://www.classcentral.com/course/youtube-core-physics-i-oscillations-and-waves-47657>

#### Section 5. Atomic and nuclear physics

1. Quantum Mechanics (Coursera)  
URL: <https://www.coursera.org/learn/quantum-mechanics>
2. Particle Physics: an Introduction (Coursera)  
URL: <https://www.coursera.org/learn/particle-physics>
3. Nuclear physics: Fundamentals and Applications (Class central from NPTEL)  
URL: <https://www.classcentral.com/course/youtube-nuclear-physics-fundamentals-and-applications-47823>
4. Understanding Modern Physics II: Quantum Mechanics and Atoms (Coursera)  
URL: <https://www.coursera.org/learn/understanding-modern-physics-2-quantum-mechanics-and-atoms>
5. Particle Physics: an Introduction (Coursera)  
URL: <https://www.coursera.org/learn/particle-physics>