



PHYSICS

Test Framework

	Content Domain	Range of Competencies	Approximate Percentage of Test Score
I.	Nature of Science	0001–0002	14%
II.	Mechanics	0003–0006	28%
III.	Electricity and Magnetism	0007–0009	22%
IV.	Waves	0010–0011	14%
V.	Modern Physics	0012–0014	22%

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I. NATURE OF SCIENCE

0001 Understand principles and procedures of scientific inquiry.

- ▶ Demonstrate knowledge of principles and procedures for designing and carrying out scientific investigations (e.g., generating and testing hypotheses).
- ▶ Recognize methods and criteria for collecting, measuring, organizing, analyzing, and presenting scientific data.
- ▶ Justify conclusions based on data analysis.
- ▶ Demonstrate knowledge of safety procedures and hazards associated with physics investigations and the equipment and technology used in physics.
- ▶ Apply appropriate mathematical procedures, including estimation, order of magnitude, statistics, and data analysis to solving problems in physics.

0002 Understand the history of science, its connections with other sciences, and the relationships among science, technology, and society.

- ▶ Demonstrate knowledge of the historical development of major scientific ideas, the contributions of eminent scientists, and the uses and limitations of models.
- ▶ Demonstrate knowledge of current major theories, models, and concepts in chemistry, biology, and Earth and space science.
- ▶ Identify unifying themes, principles, and relationships that connect physics with the different branches of the sciences.
- ▶ Analyze the interrelationships between physics, technology, engineering, and society and how science and technology affect each other.
- ▶ Demonstrate scientific literacy by critiquing the coverage of science in the media.
- ▶ Analyze social, ethical, and economic issues associated with technological and scientific developments.

II. MECHANICS

0003 Understand motion in one and two dimensions.

- ▶ Use multiple representations (e.g., pictures, graphs, motion maps) to analyze the one-dimensional motion of a particle or an object.
- ▶ Solve problems involving constant acceleration.
- ▶ Apply properties of vectors to describe and analyze motion in two dimensions, including uniform circular motion and projectile motion.
- ▶ Solve problems involving motion in two dimensions, including uniform circular motion and projectile motion.

0004 Understand forces as interactions and their effects on motion.

- ▶ Identify characteristics of Newton's laws in a variety of situations.
- ▶ Analyze free body diagrams.
- ▶ Use Newton's laws to solve problems involving force and motion, including problems involving gravitational, frictional, and elastic forces.
- ▶ Solve problems involving uniform circular motion, including satellite and planetary motion.
- ▶ Apply Newton's laws to solve problems involving systems of particles and the statics and dynamics of fluids.

0005 Understand the conservation of energy and linear momentum.

- ▶ Apply principles of work, potential energy, kinetic energy, and power to solve problems.
- ▶ Apply the work-energy theorem to conservative and nonconservative systems.
- ▶ Analyze the relationships among force, impulse, and momentum.
- ▶ Solve problems involving elastic and inelastic collisions in one and two dimensions.

0006 Understand simple harmonic motion and rotational dynamics.

- ▶ Use graphs and trigonometric functions to analyze characteristics of simple harmonic motion, such as amplitude, restoring force, frequency, and period.
- ▶ Analyze the characteristics of kinetic and potential energy for an object undergoing simple harmonic motion.
- ▶ Solve problems in rotational kinematics.
- ▶ Solve static and dynamic problems involving torques and forces.
- ▶ Analyze systems involving rotational energy and angular momentum.

III. ELECTRICITY AND MAGNETISM

0007 Understand properties of the electric field.

- ▶ Analyze phenomena related to static electricity, such as the behavior of electroscopes, induced molecular polarization, and charging by induction.
- ▶ Describe electric forces and electric fields for various simple charge distributions.
- ▶ Describe the motion of a charged particle in a constant electric field.
- ▶ Demonstrate knowledge of electric potential energy and potential difference.

0008 Understand properties of the magnetic field and electromagnetic induction.

- ▶ Demonstrate knowledge of the properties of magnets.
- ▶ Analyze the magnetic force on a moving charge in a magnetic field.
- ▶ Analyze the magnetic field for a current-carrying wire loop or solenoid.
- ▶ Apply Faraday's and Lenz's laws of induction to find the direction of an induced emf or current in a conducting loop.
- ▶ Describe the operation of devices such as electric motors, generators, and transformers.

0009 Understand properties of electric circuits.

- ▶ Demonstrate knowledge of electromotive force, electric current, resistance, and Ohm's law.
- ▶ Describe characteristics of parallel and series circuits.
- ▶ Solve problems using Kirchhoff's laws for circuits.
- ▶ Analyze an electric circuit or component in terms of energy or power.

IV. WAVES

0010 Understand the fundamental properties of waves.

- ▶ Demonstrate knowledge of the characteristics and types of waves.
- ▶ Demonstrate knowledge of wave propagation and how waves transfer energy and momentum.
- ▶ Describe factors that affect the speed of a wave in different media.
- ▶ Solve problems involving wave speed, frequency, and wavelength.
- ▶ Analyze the reflection, refraction, and polarization of waves.
- ▶ Apply the superposition principle to analyze wave phenomena.
- ▶ Demonstrate knowledge of the Doppler effect.
- ▶ Demonstrate knowledge of the relationships between a sound wave and the human perception of sound.
- ▶ Solve problems involving standing waves, resonance, and sounds produced by waves on a string or in a pipe, given various boundary conditions.
- ▶ Solve problems involving the intensity of sound and the decibel scale.

0011 Understand the characteristics of light and electromagnetic radiation.

- ▶ Demonstrate knowledge of the electromagnetic spectrum and the production and transmission of electromagnetic waves.
- ▶ Apply the ray model of light and the thin lens equation to analyze characteristics of lenses and mirrors.
- ▶ Solve problems using Snell's law in various situations.
- ▶ Apply the wave model of light to describe phenomena such as interference, dispersion, diffraction, and polarization.
- ▶ Apply properties of light to describe the operation of optical devices such as filters, magnifying devices, and diffraction gratings.
- ▶ Describe various phenomena (e.g., electron transitions, atomic spectra, operation of a laser) using the photon model of light.

V. MODERN PHYSICS

0012 Understand thermal energy and the kinetic theory of matter.

- ▶ Demonstrate knowledge of the concepts of thermal energy and temperature.
- ▶ Solve problems involving thermal expansion, specific heat, phase changes, and the first law of thermodynamics.
- ▶ Demonstrate knowledge of the kinetic theory of matter.
- ▶ Demonstrate knowledge of energy conversions, efficiency, heat transfer, and heat engines.
- ▶ Demonstrate knowledge of the second law of thermodynamics, including entropy.

0013 Understand fundamental ideas of modern physics.

- ▶ Demonstrate knowledge of the significance of the work of scientists such as Curie, Rutherford, and Planck in the development of modern physics.
- ▶ Analyze the Bohr model of the atom.
- ▶ Demonstrate knowledge of the basic principles of quantum mechanics, such as wave-particle duality and the uncertainty principle.
- ▶ Demonstrate knowledge of the basic principles of special relativity.

0014 Understand the fundamental principles of nuclear physics.

- ▶ Demonstrate knowledge of the structure of the nucleus, including the forces that hold it together.
- ▶ Apply knowledge of radioactive decay processes and the concept of the half-life to analyze and solve problems.
- ▶ Demonstrate knowledge of the processes of nuclear fission and nuclear fusion.
- ▶ Apply the principles of conservation of charge and mass-energy to analyze nuclear reactions.