Arizona Educator Proficiency Assessments (AEPA™)

FIELD 09: PHYSICS
TEST OBJECTIVES

Subarea	Range of Objectives	Approximate Test Proportions
I. Scientific Inquiry	1–5	19%
II. Mechanics and Heat Energy	6–15	36%
III. Electricity and Magnetism	16–19	15%
IV. Waves, Sound, and Light	20–23	15%
V. Quantum Theory and the Atom	24–27	15%

Arizona Educator Proficiency Assessments (AEPA™)
Subject Knowledge Test

Test Objectives
Field 09: Physics

Subareas:

Scientific Inquiry
Mechanics and Heat Energy
Electricity and Magnetism
Waves, Sound, and Light
Quantum Theory and the Atom

SCIENTIFIC INQUIRY

0001 Understand the historical and contemporary contexts of the study of physics.

For example: the significance of key events, theories, and individuals in the history of physics; the historical development of theories and knowledge in physics; the social and cultural contexts of physics; and the societal implications of developments in physics (e.g., nuclear technology, semi-conductors, superconductors).

0002 Understand the nature of science and scientific inquiry.

For example: processes by which new scientific knowledge and hypotheses are generated; processes by which science advances; the reliance of science on empirical data, verifiable evidence, and logical reasoning; ethical issues related to scientific processes (e.g., accurately reporting experimental results); and the role of communication among scientists and between scientists and the public in promoting scientific progress.

0003 Understand principles and procedures of classroom physics investigations.

For example: the identification of questions that can be answered using scientific methods; procedures and considerations in setting up and conducting a physics laboratory investigation; the use of microcomputer-based laboratory equipment (MBL) to collect and analyze data; the use of control and experimental groups to test hypotheses; the appropriateness of a specified experimental design to test a given physics hypothesis; and the selection and use of materials and techniques for physics investigations.

TEST OBJECTIVES
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0004 Understand the processes of gathering, organizing, reporting, and analyzing scientific data in the context of physics investigations.

For example: the appropriateness of a given method or procedure for collecting data for a specified purpose; the design and use of models; applications of statistics (e.g., linear regression models, correlation coefficients, percent deviation between experimental and accepted values); appropriate and effective graphic representations (e.g., graph, table, diagram) for organizing and reporting experimental data; procedures and criteria for formally reporting experimental procedures and data to the scientific community; and relationships between factors (e.g., linear, direct, inverse, direct squared, inverse squared) as indicated by experimental data.

0005 Understand the interrelationships among physics, society, technology, and other sciences and disciplines.

For example: unifying concepts and processes among the sciences; the effects of physics and technology on one another and on society; similarities and differences between science and technology (e.g., science as investigating the natural world, technology as solving human adaptation problems); ethical considerations related to science and technology; and the application of physics to other disciplines and to daily life.

MECHANICS AND HEAT ENERGY

0006 Understand concepts related to motion in one and two dimensions, and apply this knowledge to solve problems that require the use of algebra, trigonometry, and graphing.

For example: the terminology, units, and equations used to describe and analyze one- and two-dimensional motion; the difference between instantaneous and average velocity; the movement of freely falling objects near the surface of the earth; solving problems involving distance, displacement, speed, velocity, and constant acceleration; and analyzing interrelationships among displacement-versus-time, velocity-versus-time, and acceleration-versus-time graphs.

0007 Understand the vector nature of forces and methods used to measure force; and solve conceptual, graphical, and algebraic problems involving forces.

For example: identifying forces acting in a given situation; finding the resultant force using graphical and trigonometric methods; experimental designs for measuring forces; solving problems involving gravitational and frictional forces; and solving problems involving static equilibrium.

TEST OBJECTIVES
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0008 Understand the laws of motion (including relativity) and conservation of momentum.

For example: the characteristics and examples of each of Newton's laws of motion; applying Newton's laws of motion and the conservation of momentum in solving problems; and the implications of special relativity for the laws of motion.

0009 Understand the characteristics of circular motion and simple harmonic motion, and solve problems involving these types of motion.

For example: applying vector analysis to describe uniform circular motion; determining the magnitude and direction of the force acting on a particle in uniform circular motion; the relationships among displacement, velocity, and acceleration in simple harmonic motion (e.g., simple pendulum); and solving problems involving mass-spring systems.

0010 Understand the law of universal gravitation, and apply it to satellite motion.

For example: the geometric characteristics of planetary orbits; using the law of universal gravitation to interpret the relationship among force, mass, and the distance between masses; and applying the law of universal gravitation to analyze satellite motion.

0011 Understand the principle of conservation of energy and the concepts of energy, work, and power.

For example: analyzing mechanical systems in terms of work, power, and conservation of energy; applying the concept of conservation of energy to solve problems; and determining power and efficiency as they relate to work and energy in operations such as simple machines.

0012 Understand the dynamics of rotational motion, including torque, angular momentum, motion with constant angular acceleration, rotational kinetic energy, center of mass, and moment of inertia.

For example: the principles of motion with constant angular acceleration; the law of conservation of angular momentum; and the concepts of center of mass, moment of inertia, and rotational kinetic energy.

0013 Understand the statics and dynamics of fluids.

For example: the concepts of force, pressure, and density; using Bernoulli's principle to analyze fluid dynamics; and applying Archimedes' principle to solve problems involving buoyancy and flotation.

0014 Understand the principles of the first and second laws of thermodynamics, the relationship between temperature and heat, and the principles of thermal expansion, thermal contraction, and heat transfer.

For example: solving calorimetry problems involving heat capacity, specific heat, heat of fusion, and heat of vaporization; analyzing methods of heat transfer (i.e., conduction, convection, radiation) in practical situations; solving problems involving thermal expansion and thermal contraction of solids; analyzing the relationship among heat, work, and internal energy; and using the principle of entropy to analyze energy conversions.

0015 Understand the kinetic-molecular theory and its relationship to thermodynamics and the characteristics of solids, liquids, and gases.

For example: analyzing the behavior of a gas in terms of the kinetic-molecular theory (i.e., ideal gas law, temperature and kinetic energy); and analyzing phase changes in terms of kinetic-molecular theory and molecular structure.

ELECTRICITY AND MAGNETISM

0016 Understand characteristics and units of electric charge, electric fields, electric potential, and capacitance; and apply principles of static electricity to solve problems involving Coulomb's law and electric fields.

For example: analyzing the behavior of an electroscope in given situations; applying Coulomb's law to determine the forces between charges; applying principles of electrostatics to determine electric field intensity; and the relationships between capacitance, charge, and potential difference.

0017 Understand characteristics of electric current and components of electric circuits.

For example: analyzing DC circuits (both with and without capacitors) in terms of conservation of energy and conservation of charge (i.e., Kirchhoff's laws, Ohm's law); factors that affect resistance; schematic diagrams of electric circuits; and applying principles of DC circuits to reduce a complex circuit to a simpler equivalent circuit.

0018 Understand the force on a charge in a magnetic field, and understand magnets, magnetic fields, and electromagnets.

For example: the magnitude and direction of the force on a charge or charges moving in a magnetic field; factors that affect the strength of an electromagnet; the orientation and magnitude of a magnetic field; and the use of electromagnetism in technology (e.g., motors, generators, meters).

0019 Understand and apply the principles of electromagnetic induction and AC circuits.

For example: determining the direction of an induced current; factors that affect the magnitude of an induced electromotive force (EMF); analyzing an AC circuit, including relationships involving impedance and reactance; and the functions of transformers and generators.

WAVES, SOUND, AND LIGHT

0020 Understand waves, wave motion, and wave interference.

For example: types (e.g., longitudinal, transverse) and characteristics (e.g., frequency, period, amplitude, wavelength) of waves; understand the relationship among a wave's velocity, wavelength, and frequency; and apply the superposition principle to solve problems involving constructive and destructive interference.

0021 Understand the characteristics of sound waves and the means by which sound waves are produced and transmitted.

For example: the physical nature of sound waves (including intensity and intensity level); factors that affect the speed of sound in different media; solving problems involving resonance, harmonics, and overtones; and the Doppler effect.

0022 Understand the production and characteristics of electromagnetic waves.

For example: the properties (e.g., energy, frequency, wavelength) of components of the electromagnetic spectrum (e.g., visible light, ultraviolet radiation); applications of the components of the electromagnetic spectrum (e.g., infrared detectors, solar heating, x-ray machines); and using wave properties to explain interference in single and multiple slits and thin films.

0023 Understand the principles of reflection and refraction.

For example: applying Snell’s law to determine the index of refraction, angle of incidence, angle of refraction, and the critical angle; types and characteristics of lenses and mirrors; using a ray diagram to locate the focal point or point of image formation of a lens or mirror; applying the lens and mirror equations to solve problems involving lenses and mirrors; and applications of lenses and mirrors (e.g., telescopes, compound microscopes, eyeglasses).

TEST OBJECTIVES
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QUANTUM THEORY AND THE ATOM

0024 Understand the principles and concepts of the photoelectric effect, quantum theory, and the wave and particle nature of light and matter.

For example: applying the laws of photoelectric emission to explain photoelectric phenomena; analyzing bright-line spectra in terms of electron transitions; and the principles of stimulated emission of radiation as applied to lasers.

0025 Understand physical models of atomic structure and the nature of elementary particles.

For example: historic and contemporary models of atomic structure (e.g., Bohr, Schrödinger, Heisenberg, Mayer, Bhabha); notation used to represent elements, molecules, ions, and isotopes; and the use of particle accelerators to explore elementary particle characteristics.

0026 Understand the principles of radioactivity, the types and characteristics of radiation, and the process of radioactive decay.

For example: applying principles of the conservation of mass-energy and charge to balance equations for nuclear reactions; analyzing radioactive decay in terms of the half-life concept; analyzing the nuclear disintegration series for a given isotope; and the basic operation of types of radiation detectors.

0027 Understand types and characteristics of nuclear reactions, methods of initiating and controlling them, and applications of nuclear reactions to the generation of electricity.

For example: characteristics of fission and fusion reactions; the operation of components of a nuclear reactor (e.g., moderator, fuel rods, control rods); calculating nuclear mass defect and binding energy; the isotopes commonly used to fuel nuclear reactors; and the problems associated with the waste products generated by nuclear reactions.