Physics

Overview

The standards establish the scientific inquiry skills and core content for all courses in DoDEA schools. The learning framework of this course focuses on the basic concepts of physics in relation to properties and measurable variables associated with force and motion and energy. The fundamental laws of mechanics are introduced, along with measurement and problem-solving techniques. Other topics included are wave theory, heat, sound, light, magnetism, electricity, atomic structure, nuclear reactions, and high energy physics. Within this broad view of the framework are specific concepts that are important in understanding of the physical laws fundamental to all sciences. These include: the Laws of Motion, velocity and acceleration, vectors, work, torque, equilibrium, energy transformations and transfer, magnetism and electromagnetism, electricity, electric circuits and fields, wave structure and behavior, and optics.

All DoDEA science courses are laboratory courses (minimum of 30 percent hands-on investigation). Physics laboratories will need to be stocked with all of the materials and apparatuses necessary to complete investigations. Instructional activities are staged in appropriate settings. They include laboratories, classrooms and forms of technology. Teaching strategies include in depth laboratory investigations, demonstrations, collaborative peer-to-peer discussions, and student hands-on experiences. The analysis students make of their findings requires that they work with charts, diagrams, and models. At each point in the sequence of inquiries, the students draw on lessons they learned in the investigations that preceded it. All aspects of progress in science are measured using multiple methods such as authentic assessments, performance assessments, formative assessments, observational assessments, projects, research activities, reports, group and individual student work and conventional summative assessments.

Scientific Inquiry

The skills of scientific inquiry, including knowledge and use of tools, are not taught as separate skills in science, but are embedded throughout because these process skills are fundamental to all science instruction and content. A table of the PK–12 of scientific inquiry standards and Indicators: is provided in appendix A.

Standard:	**Pa:**	**The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.**
Indicators:	**Pa.1:**	Apply established rules for significant digits, both in reading scientific instruments and in calculating derived quantities from measurement.
	Pa.2:	Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.
	Pa.3:	Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.
	Pa.4:	Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.
	Pa.5:	Organize and interpret the data from a controlled scientific investigation by using (including calculations in scientific notation, formulas, and dimensional analysis), graphs, tables, models, diagrams, and/or technology.
	Pa.6:	Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.
	Pa.7:	Evaluate conclusions based on qualitative and quantitative data (including the impact of parallax, instrument malfunction, or human error) on experimental results.
	Pa.8:	Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).
	Pa.9:	Communicate and defend a scientific argument or conclusion.
	Pa.10:	Use appropriate safety procedures when conducting investigations.
Standard:	**Pb:**	**The student will demonstrate an understanding of the principles of force and motion and relationships between them.**
Indicators:	**Pb.1:**	Represent vector quantities (including displacement, velocity, acceleration, and force) and use vector addition.
	Pb.2:	Apply formulas for velocity or speed and acceleration to one and two-dimensional problems.
	Pb.3:	Interpret the velocity or speed and acceleration of one and two-dimensional motion on

		distance-time, velocity-time or speed-time, and acceleration-time graphs.
	Pb.4:	Interpret the resulting motion of objects by applying Newton's three laws of motion: inertia; the relationship among net force, mass, and acceleration (using F = ma); and action and reaction forces.
	Pb.5:	Explain the factors that influence the dynamics of falling objects and projectiles.
	Pb.6:	Apply formulas for velocity and acceleration to solve problems related to projectile motion.
	Pb.7:	Use a free-body diagram to determine the net force and component forces acting upon an object.
	Pb.8:	Distinguish between static and kinetic friction and the factors that affect the motion of objects.
	Pb.9:	Explain how torque is affected by the magnitude, direction, and point of application of force.
	Pb.10:	Explain the relationships among speed, velocity, acceleration, and force in rotational systems.
Standard:	**Pc:**	**The student will demonstrate an understanding of the conservation, transfer, and transformation of mechanical energy.**
Indicators:	**Pc.1:**	Apply energy formulas to determine potential and kinetic energy and explain the transformation from one to the other.
	Pc.2:	Apply the law of conservation of energy to the transfer of mechanical energy through work.
	Pc.3:	Explain, both conceptually and quantitatively, how energy can transfer from one system to another (including work, power, and efficiency).
	Pc.4:	Explain, both conceptually and quantitatively, the factors that influence periodic motion.
	Pc.5:	Explain the factors involved in producing a change in momentum (including impulse and the law of conservation of momentum in both linear and rotary systems).
	Pc.6:	Compare elastic and inelastic collisions in terms of conservation laws.
Standard:	**Pd:**	**The student will demonstrate an understanding of the properties of electricity and magnetism and the relationships between them.**
Indicators:	**Pd.1:**	Recognize the characteristics of static charge and explain how a static charge is generated.
	Pd.2:	Use diagrams to illustrate an electric field (including point charges and electric field lines).
	Pd.3:	Summarize current, potential difference, and resistance in terms of electrons.

	Pd.4:	Compare how current, voltage, and resistance are measured in a series and in a parallel electric circuit and identify the appropriate units of measurement.
	Pd.5:	Analyze the relationships among voltage, resistance, and current in a complex circuit by using Ohm's law to calculate voltage, resistance, and current at each resistor, any branch, and the overall circuit.
	Pd.6:	Differentiate between alternating current (AC) and direct current (DC) in electrical circuits.
	Pd.7:	Carry out calculations for electric power and electric energy for circuits.
	Pd.8:	Summarize the function of electrical safety Indicators (including fuses, surge protectors, and breakers).
	Pd.9:	Explain the effects of magnetic forces on the production of electrical currents and on current carrying wires and moving charges.
	Pd.10:	Distinguish between the function of motors and generators on the basis of the use of electricity and magnetism by each.
	Pd.11:	Predict the cost of operating an electrical device by determining the amount of electrical power and electrical energy in the circuit.
Standard:	**Pe:**	**The student will demonstrate an understanding of the properties and behaviors of mechanical and electromagnetic waves.**
Indicators:	**Pe.1:**	Analyze the relationships among the properties of waves (including energy, frequency, amplitude, wavelength, period, phase, and speed).
	Pe.2:	Compare the properties of electromagnetic and mechanical waves.
	Pe.3:	Analyze wave behaviors (including reflection, refraction, diffraction, and constructive and destructive interference).
	Pe.4:	Distinguish the different properties of waves across the range of the electromagnetic spectrum.
	Pe.5:	Illustrate the interaction of light waves with optical lenses and mirrors by using Snell's law and ray diagrams.
	Pe.6:	Summarize the operation of lasers and compare them to incandescent light.
Standard	**Pf:**	**The student will demonstrate an understanding of the properties and behaviors of sound.**
Indicators:	**Pf.1:**	Summarize the production of sound and its speed and transmission through various media.
	Pf.2:	Explain how frequency and intensity affect the parts of the sonic spectrum.
	Pf.3:	Explain pitch, loudness, and tonal quality in terms of wave characteristics that determine what is heard.

	Pf.4:	Compare intensity and loudness.
	Pf.5:	Apply formulas to determine the relative intensity of sound.
	Pf.6:	Apply formulas in order to solve for resonant wavelengths in problems involving open and closed tubes.
	Pf.7:	Explain the relationship among frequency, fundamental tones, and harmonics in producing music.
	Pf.8:	Explain how musical instruments produce resonance and standing waves.
	Pf.9:	Explain how the variables of length, width, tension, and density affect the resonant frequency, harmonics, and pitch of a vibrating string.
Standard*:*	**Pg:**	**The student will demonstrate an understanding of the properties and behaviors of light and optics.**
Indicators:	**Pg.1:**	Explain the particulate nature of light as evidenced in the photoelectric effect.
	Pg.2:	Use the inverse square law to determine the change in intensity of light with distance.
	Pg.3:	Illustrate the polarization of light.
	Pg.4:	Summarize the operation of fiber optics in terms of total internal reflection.
	Pg.5:	Summarize image formation in microscopes and telescopes (including reflecting and refracting).
	Pg.6:	Summarize the production of continuous, emission, or absorption spectra.
	Pg.7:	Compare color by transmission to color by reflection.
	Pg.8:	Compare color mixing in pigments to color mixing in light.
	Pg.9:	Illustrate the diffraction and interference of light.
	Pg.10:	Identify the parts of the eye and explain their function in image formation.
Standard:	**Ph:**	**The student will demonstrate an understanding of nuclear physics and modern physics.**
Indicators:	**Ph.1:**	Compare the strong and weak nuclear forces in terms of their roles in radioactivity.
	Ph.2:	Compare the nuclear binding energy to the energy released during a nuclear reaction, given the atomic masses of the constituent particles.
	Ph.3:	Predict the resulting isotope of a given alpha, beta, or gamma emission.
	Ph.4:	Apply appropriate procedures to balance nuclear equations (including fusion, fission, alpha decay, beta decay, and electron capture).

	Ph.5:	Interpret a representative nuclear decay series.
	Ph.6:	Explain the relationship between mass and energy that is represented in the equation $E = mc^2$ according to Einstein's special theory of relativity.
	Ph.7:	Compare the value of time, length, and momentum in the reference frame of an object moving at relativistic velocity to those values measured in the reference frame of an observer by applying Einstein's special theory of relativity.
Standard:	**Pi:**	**The student will demonstrate an understanding of the principles of fluid mechanics.**
Indicators:	**Pi.1:**	Predict the behavior of fluids (including changing forces) in pneumatic and hydraulic systems.
	Pi.2:	Apply appropriate procedures to solve problems involving pressure, force, volume, and area.
	Pi.3:	Explain the factors that affect buoyancy.
	Pi.4:	Explain how the rate of flow of a fluid is affected by the size of the pipe, friction, and the viscosity of the fluid.
	Pi.5:	Explain how depth and fluid density affect pressure.
	Pi.6:	Apply fluid formulas to solve problems involving work and power.
	Pi.7:	Exemplify the relationship between velocity and pressure by using Bernoulli's principle.
Standard:	**Pj:**	**The student will demonstrate an understanding of the principles of thermodynamics.**
Indicators:	**Pj.1:**	Summarize the first and second laws of thermodynamics.
	Pj.2:	Explain the relationship among internal energy, heat, and work.
	Pj.3:	Exemplify the concept of entropy.
	Pj.4:	Explain thermal expansion in solids, liquids, and gases in terms of kinetic theory and the unique behavior of water.
	Pj.5:	Differentiate heat and temperature in terms of molecular motion.
	Pj.6:	Summarize the concepts involved in phase change.
	Pj.7:	Apply the concepts of heat capacity, specific heat, and heat exchange to solve calorimetry problems.
	Pj.8:	Summarize the functioning of heat transfer mechanisms (including engines and refrigeration systems).