

High School Core Science Standards

Physics Applications

Physics Application Overview

The academic standards for Physics Applications establish the scientific inquiry skills and core content for all Physics Applications classes in DoDEA schools. The course should provide students with a conceptual understanding of the world around them—a basic knowledge of the physical universe that should serve as the foundation for other high school science courses.

Teachers, schools, and districts should use these standards to make decisions concerning the structure and content for Physics Applications classes that are taught in their schools. These decisions will involve choices regarding additional content, activities, and learning strategies and will depend on the particular objectives of the individual classes. All Physics Applications classes must include inquiry-based instruction, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. In other words, students should spend more of their class time choosing the right method to solve a problem and less time solving problems that merely call for repetitive procedures.

Physics Applications is a laboratory course (minimum of 30 percent hands-on investigation) that integrates principles of chemistry and physics. Physics Applications laboratories will need to be stocked with all of the materials and apparatuses necessary to complete investigations in both the chemistry and physics portions of the course.

High School Core Science Standards

Physics Applications

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 scientific inquiry standards and indicators is located in appendix A.

Standard: **PAa:** **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:**
- PAa.1:** Generate hypotheses on the basis of credible, accurate, and relevant sources of scientific information.
 - PAa.2:** Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.
 - PAa.3:** Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.
 - PAa.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.
 - PAa.5:** Organize and interpret the data from a controlled scientific investigation by using mathematics (including formulas and dimensional analysis), graphs, models, and/or technology.
 - PAa.6:** Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.
 - PAa.7:** Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).
 - PAa.8:** Compare the processes of scientific investigation and technological design.
 - PAa.9:** Use appropriate safety procedures when conducting investigations.

Structure and Properties of Matter

Standard: **PAb:** **The student will demonstrate an understanding of the structure and properties of atoms.**

- Indicators:**
- PAb.1:** Compare the subatomic particles (protons, neutrons, electrons) of an atom with regard to mass, location, and charge, and explain how these particles affect the properties of an atom (including identity, mass, volume, and reactivity).
 - PAb.2:** Illustrate the fact that the atoms of elements exist as stable or unstable isotopes.
 - PAb.3:** Compare fission and fusion (including the basic processes and the fact that both fission and fusion convert a fraction of the mass of interacting particles into energy and release a great amount of energy)..

High School Core Science Standards

Physics Applications

PAb.4: Compare the properties of the four states of matter—solid, liquid, gas, and plasma—in terms of the arrangement and movement of particles..

The Interactions of Matter and Energy

Standard: **PAc:** **The student will demonstrate an understanding of the nature of forces and motion.**

Indicators: **Pac.1** Explain the relationship among distance, time, direction, and the velocity of an object.

Pac.2 Use the formula $\mathbf{v} = \mathbf{d}/\mathbf{t}$ to solve problems related to average speed or velocity.

Pac.3 Explain how changes in velocity and time affect the acceleration of an object.

Pac.4 Use the formula $\mathbf{a} = (\mathbf{v}_f - \mathbf{v}_i)/\mathbf{t}$ to determine the acceleration of an object.

Pac.5 Explain how acceleration due to gravity affects the velocity of an object as it falls.

Pac.6 Represent the linear motion of objects on distance-time graphs.

Pac.7 Explain the motion of objects based on Newton's three laws of motion: inertia; the relationship among force, mass, and acceleration; and action and reaction forces.

Pac.8 Use the formula $\mathbf{F} = \mathbf{ma}$ to solve problems related to force.

Pac.9 Explain the relationship between mass and weight by using the formula $\mathbf{F}_w = \mathbf{ma}_g$.

Pac.10 Explain how the gravitational force between two objects is affected by the mass of each object and the distance between them.

Pac.11 Investigates stress and strain in static materials subject to compression or tension.

Standard: **PAd:** **The student will demonstrate an understanding of the nature, conservation, and transformation of energy.**

Indicators: **PAd.1:** Explain how the law of conservation of energy applies to the transformation of various forms of energy (including mechanical energy, electrical energy, chemical energy, light energy, sound energy, and thermal energy).

PAd.2 Explain the factors that determine potential and kinetic energy and the transformation of one to the other.

PAd.3 Explain work in terms of the relationship among the force applied to an object, the displacement of the object, and the energy transferred to the object.

PAd.4 Use the formula $\mathbf{W} = \mathbf{Fd}$ to solve problems related to work done on an object.

High School Core Science Standards

Physics Applications

- Standard:** **PAe:** **The student will demonstrate an understanding of the nature and properties of mechanical and electromagnetic waves.**
- Indicators:** **PAe.1:** Illustrate ways that the energy of waves transfer by interaction with matter (including transverse and longitudinal/compressional waves).
- PAe.2:** Compare the nature and properties of transverse and longitudinal/compressional mechanical waves.
- PAe.3:** Summarize characteristics of waves (including displacement, frequency, period, amplitude, wavelength, and velocity as well as the relationship-among these characteristics).
- PAe.4:** Use the formulas $v = f \lambda$ and $v = d/t$ to solve problems related to the velocity of waves.
- PAe.5:** Summarize the characteristics of the electromagnetic spectrum (including range of wavelengths, frequency, energy, and propagation without a medium).
- PAe.6:** Summarize reflection and interference of both sound and light waves and the refraction and diffraction of light waves.
- PAe.7:** Explain the Doppler Effect conceptually in terms of the frequency of the waves and the pitch of the sound.
- Standard** **PAf:** **The student will demonstrate an understanding of the nature and properties of electricity and magnetism.**
- Indicators:** **PAf.1:** Explain the relationship of magnetism to the movement of electric charges in electromagnets, simple motors, and generators.
- PAf.2:** Explain how objects can acquire a static electric charge through friction, induction, and conduction.
- PAf.3:** Explain the relationship among voltage, resistance, and current in Ohm's law.
- PAf.4:** Use the formula $V = IR$ to solve problems related to electric circuits.
- PAf.5:** Represent an electric circuit by drawing a circuit diagram that includes the symbols for a resistor, switch, and voltage source.
- PAf.6:** Compare the functioning of simple series and parallel electrical circuits.