

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 of scientific inquiry standards and Indicators: is provided 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.

Chemistry: 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:	Explain the trends of the periodic table based on the elements' valence electrons and atomic numbers.

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- PAb.4:** Use the atomic number and the mass number to calculate the number of protons, neutrons, and/or electrons for a given isotope of an element.
- PAb.5:** Predict the charge that a representative element will acquire according to the arrangement of electrons in its outer energy level.
- PAb.6:** 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).
- PAb.7:** Explain the consequences that the use of nuclear applications (including medical technologies, nuclear power plants, and nuclear weapons) can have.

Chemistry: Structure and Properties of Matter

Standard: **PAc:** **The student will demonstrate an understanding of various properties and classifications of matter.**

- Indicators:** **PAc.1:** Distinguish chemical properties of matter (including reactivity) from physical properties of matter (including boiling point, freezing/melting point, density [with density calculations], solubility, viscosity, and conductivity).
- PAc.2:** Infer the practical applications of organic and inorganic substances on the basis of their chemical and physical properties.
- PAc.3:** Illustrate the difference between a molecule and an atom.
- PAc.4:** Classify matter as a pure substance (either an element or a compound) or as a mixture (either homogeneous or heterogeneous) on the basis of its structure and/or composition.
- PAc.5:** Explain the effects of temperature, particle size, and agitation on the rate at which a solid dissolves in a liquid.
- PAc.6:** Compare the properties of the four states of matter—solid, liquid, gas, and plasma—in terms of the arrangement and movement of particles.
- PAc.7:** Explain the processes of phase change in terms of temperature, heat transfer, and particle arrangement.
- PAc.8:** Classify various solutions as acids or bases according to their physical properties, chemical properties (including neutralization and reaction with metals), generalized formulas, and pH (using pH meters, ~~or~~ pH paper, and litmus paper).

Chemistry: Structure and Properties of Matter

Standard: **PAd:** **The student will demonstrate an understanding of chemical reactions and the classifications, structures, and properties of chemical compounds.**

- Indicators:** **PAd.1:** Explain the role of bonding in achieving chemical stability.

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- PAd.2:** Explain how the process of covalent bonding provides chemical stability through the sharing of electrons.
- PAd.3:** Illustrate the fact that ions attract ions of opposite charge from all directions and form crystal lattices.
- PAd.4:** Classify compounds as crystalline (containing ionic bonds) or molecular (containing covalent bonds) based on whether their outer electrons are transferred or shared.
- PAd.5:** Predict the ratio by which the representative elements combine to form binary ionic compounds, and represent that ratio in a chemical formula.
- PAd.6:** Distinguish between chemical changes (including the formation of gas or reactivity with acids) and physical changes (including changes in size, shape, color, and/or phase).
- PAd.7:** Summarize characteristics of balanced chemical equations (including conservation of mass and changes in energy in the form of heat—that is, exothermic or endothermic reactions).
- PAd.8:** Summarize evidence (including the evolution of gas; the formation of a precipitate; and/or changes in temperature, color, and/or odor) that a chemical reaction has occurred.
- PAd.9:** Apply a procedure to balance equations for a simple synthesis or decomposition reaction.
- PAd.10:** Recognize simple chemical equations (including single replacement and double replacement) as being balanced or not balanced.
- PAd.11:** Explain the effects of temperature, concentration, surface area, and the presence of a catalyst on reaction rates.

Physics: The Interactions of Matter and Energy

- Standard:** **PAe:** **The student will demonstrate an understanding of the nature of forces and motion.**
- Indicators:** **PAe.1:** Explain the relationship among distance, time, direction, and the velocity of an object.
- PAe.2:** Use the formula $v = d/t$ to solve problems related to average speed or velocity.
- PAe.3:** Explain how changes in velocity and time affect the acceleration of an object.
- PAe.4:** Use the formula $a = (v_f - v_i)/t$ to determine the acceleration of an object.
- PAe.5:** Explain how acceleration due to gravity affects the velocity of an object as it falls.

High School Core Science Standards Physics Applications

- PAe.6:** Represent the linear motion of objects on distance-time graphs.
- PAe.7:** Explain the motion of objects on the basis of Newton's three laws of motion: inertia; the relationship among force, mass, and acceleration; and action and reaction forces.
- PAe.8:** Use the formula $F = ma$ to solve problems related to force.
- PAe.9:** Explain the relationship between mass and weight by using the formula $F_w = ma_g$.
- PAe.10:** Explain how the gravitational force between two objects is affected by the mass of each object and the distance between them.

Physics: The Interactions of Matter and Energy

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| Standard | PAf: | The student will demonstrate an understanding of the nature, conservation, and transformation of energy. |
| Indicators: | PAf.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). |
| | PAf.2: | Explain the factors that determine potential and kinetic energy and the transformation of one to the other. |
| | PAf.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. |
| | PAf.4: | Use the formula $W = Fd$ to solve problems related to work done on an object. |
| | PAf.5: | Explain how objects can acquire a static electric charge through friction, induction, and conduction. |
| | PAf.6: | Explain the relationships among voltage, resistance, and current in Ohm's law. |
| | PAf.7: | Use the formula $V = IR$ to solve problems related to electric circuits. |
| | PAf.8: | Represent an electric circuit by drawing a circuit diagram that includes the symbols for a resistor, switch, and voltage source. |
| | PAf.9: | Compare the functioning of simple series and parallel electrical circuits. |
| | PAf.10: | Compare alternating current (AC) and direct current (DC) in terms of the production of electricity and the direction of current flow. |
| | PAf.11: | Explain the relationship of magnetism to the movement of electric charges in electromagnets, simple motors, and generators. |