High School Physics

Essential Standards Extended Guide

HIGH SCHOOL PHYSICS

Background information about this document:

In response to requests from schools and districts for guidance on essential standards, committees of educators from around Idaho collaborated in the summer of 2024 to categorize Science standards into three groups:

1. **Essential standards** are explicitly taught, assessed multiple times, and receive targeted interventions for students who have not yet reached proficiency.
2. **Supporting standards** are taught to reinforce essential standards and may or may not be formally assessed.
3. **Additional standards** extend learning and are incorporated as time allows within course units, with assessment being optional.

This guidance helps LEAs prioritize the most critical standards, recognizing that not all standards are of equal importance. This document serves as a resource—not a mandate—to assist local efforts. Importantly, this work did not remove or revise any of the adopted Idaho Content Standards and is intended to refocus time and effort.

The committees developed instructional grouping models to demonstrate how standards can be combined into focused units. However, this is just one approach, and other combinations are possible. Educators can use this guide to begin developing scope and sequence for their instructional time and district-specific courses. It also provides a useful starting point for creating formative and summative assessments aligned with the standards.

Instructional Grouping 1: Forces and Collisions

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	Supporting Standards and Content **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSP-1.3 - Collisions and A Force Minimizing Device Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. Limited to one-dimensional motion of macroscopic objects at non-relativistic speeds.	If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PSP-1.2, HS-PSP-1.3) Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-PSP-1.3) Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-PSP-1.3)
HS-PSP-1.1 - Newton's 2nd Law Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.	Newton's second law accurately predicts changes in the motion of macroscopic objects. (HSPSP-1.1)
HS-PSP-1.2 - Conservation of Momentum Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.	Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PSP-1.2) If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PSP-1.2, HS-PSP-1.3)

Note: Essential standards 1.1 and 1.2 work together to support essential standard 1.3. When teaching and assessing students on 1.3 be sure students are analyzing data and using mathematical representations to support their claims.

Further explanation:

1. Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.

2. Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle (Newton's first law).
3. Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute

Assessment limits:

4. Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.
5. Assessment is limited to systems of two macroscopic bodies moving in one dimension
6. Assessment is limited to qualitative evaluations and/or algebraic manipulations

Instructional Grouping 2: Forces and Distance

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSP-1.5 - Electromagnetic Induction Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.	Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PSP-1.4, HS-PSP1.5) "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. (HS-PSP-1.5)
HS-PSP-1.4 - Inverse Square Laws (Forces at a distance) Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.	Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PSP-1.4) Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PSP-1.4, HS-PSP1.5)

Further explanation:

1. Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.

Assessment limits:

1. Assessment is limited to designing and conducting investigations with provided materials and tools.
2. Assessment is limited to systems with two objects. Base equations will be provided.

Instructional Grouping 3: Material Design

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSP-1.6 - Material Design Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.	The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PSP-1.6) Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PSP-1.6, HS-PSC-1.3, HS-PSC-1.5)

Further explanation:

1. Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.

Assessment limits:

1. Assessment is limited to provided molecular structures of specific designed materials.

Instructional Grouping 4: Energy Transfer

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSP-2.1 - Energy Transfer Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.	Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PSP-2.1, HS-PSP-2.2) Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PSP-2.1) Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PSP-2.1, HS-PSP-2.4) Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PSP-2.1) The availability of energy limits what can occur in any system. (HS-PSP-2.1)

Further explanation:

1. Emphasis is on explaining the meaning of mathematical expressions used in the model.

Assessment limits:

1. Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.

Instructional Grouping 5: Conservation of Energy

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSP-2.2 - Conservation of Energy Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).	Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PSP-2.1, HS-PSP-2.2) At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PSP-2.2, HS-PSP-2.3) These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases, the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PSP-2.2)

Further explanation:

1. Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.

Instructional Grouping 6: Energy Transfers

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSP-2.3 - Design a Device Utilizing Energy Transfers Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.	At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PSP-2.2, HS-PSP-2.3) Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PSP-2.3, HS-PSP-2.4) Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-PSP-2.3)

Further explanation:

1. Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of multiple energy forms and evaluations of efficiency.

Assessment limits:

1. Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to examples of devices provided to students.

Instructional Grouping 7: Thermodynamics

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	Supporting Standards and Content **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSP-2.4 - 2nd Law of Thermodynamics Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).	Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PSP-2.1, HS-PSP-2.4) Uncontrolled systems always evolve toward more stable states—that is, toward a more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PSP-2.4) Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PSP-2.3, HS-PSP-2.4)

Further explanation:

1. Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.

Assessment limits:

1. Assessment is limited to examples of closed system investigations.

Instructional Grouping 8: Energy In Fields

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSP-2.5 - Energy In Fields Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.	When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PSP-2.5)

Further explanation:

1. Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.

Assessment limits:

1. Assessment is limited to systems containing two objects.

Instructional Grouping 9 Wave Mechanics

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSP-3.1 - Wave Mechanics Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.	The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PSP-3.1)

Further explanation:

1. Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.

Assessment limits:

1. Assessment is limited to algebraic relationships and describing those relationships qualitatively.

Instructional Grouping 9 Wave Mechanics

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	**Supporting Standards and Content** **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSP-3.4 - Light-Matter Interactions Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.	When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PSP-3.4)
HS-PSP-3.3 - Wave-Particle Duality Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.	Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PSP-3.3) Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PSP-3.3)

Further explanation:

1. Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias
2. Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.

Assessment limits:

1. Assessment is limited to qualitative descriptions.
2. Assessment does not include using quantum theory.

Instructional Group 11: Technology and Wave Behavior

Essential Standards **Standards are to be explicitly taught, assessed more than once, and intervened upon in this cluster of standards.**	Supporting Standards and Content **Taught to support the learning of essential standards and may or may not be formally assessed.**
HS-PSP-3.5 - Technology and Wave Behavior Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.	Solar cells are human-made devices that likewise capture the Sun's energy and produce electrical energy. (HS-PSP-3.5) Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PSP-3.2, HS-PSP-3.5) Photoelectric materials emit electrons when they absorb light of a high enough frequency. (HS-PSP-3.5) Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PSP-3.5)

Additional Standards **If time allows, these standards may be taught and/or assessed with Instructional Group 11.**
HS-PSP-3.2 - Digital Transmissions Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Further explanation:

1. Examples could include solar cells capturing light and converting it to electricity, medical imaging, and communications technology.

Assessment limits:

1. Assessments are limited to qualitative information. Assessments do not include band theory.

Guidance for Physics from Physics teacher group:

In categorizing the standards for high school physics, we focused on concepts that we felt would be important for citizens of Idaho to comprehend. The standards adopted in 2022 place higher emphasis on more “modern” physics than “classical” physics. Much more time is spent on electricity, magnetism, and waves than on kinematics and dynamics. Also, a heavier emphasis on momentum and energy is included compared to what was traditionally taught in physics classes.

We decided that the idea of the inverse square laws of Newton’s Law of Universal Gravitation and Coulomb’s Law (HS-PSP-1.4) would provide a good support to the concept of electromagnetic induction present in standard HS-PSP-1.5. The source of power generation is essential for citizens that use power to understand where their electricity comes from. Part of the hope here is that we inspire young people to think about novel sources of generating electricity.

When talking about Newton’s Law of Universal Gravitation, some emphasis might be placed on the idea that these concepts align well with 17th century understanding of classical mechanics and works well most of the time, but our understanding of the source of gravity is still being developed (i.e. general theory of relativity, mass warps space-time, which causes what we call gravity).

For further clarification on supporting content, explanations of standards, and assessment limits please utilize the Idaho Science Standards.

For Questions Contact

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