High School Physics: Year at a Glance

UNIT 1, FORCES AND MOTION

Instructional days: **25**

Essential question: How can one explain and predict interactions between objects and within systems of objects?

Unit abstract: In this unit of study, students will develop an understanding of ideas related to why some objects keep moving and some objects fall to the ground. Students will build an understanding of forces and Newton's second law. They also develop an understanding that the total momentum of a system of objects is conserved when there is no net force on the system. Students are able to apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. The crosscutting concepts of patterns, cause and effect, and systems and systems models are called out as organizing concepts for these disciplinary core ideas. In the PS2 performance expectations, students are expected to demonstrate proficiency in planning and conducting investigations, analyzing data and using math to support claims, and applying scientific ideas to solve design problems and to use these practices to demonstrate understanding of the core ideas.

PE DCI	Performance Expectation	Grade Band DCI Connections			Science and Engineering Practices	Crosscutting Concepts
		Physical Science	Life Science	Earth and Space Science		
HS-PS2-1 PS2.A	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.	PS3.A		ESS1.A ESS1.C ESS2.C	Analyzing and Interpreting Data	Cause and Effect
HS-PS2-2 PS2.A	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.			ESS1.A ESS1.C	Using Mathematics and Computational Thinking	Systems and System Models
HS-PS2-3* PS2.A ETS1.A ETS1.C	Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.				Constructing Explanations and Designing Solutions	Cause and Effect
HS-ETS1-2 ETS1.C	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.				Constructing Explanations and Designing Solutions	
HS-ETS1-3 ETS1.B	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.				Constructing Explanations and Designing Solutions	

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Notes:

UNIT 2, FUNDAMENTAL FORCES

Instructional days: 15

Essential question: How can one explain and predict interactions between objects and within systems of objects?

Unit abstract: In this unit of study, students will use Newton's law of gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. In the PS2 performance expectations, students are expected to demonstrate proficiency in planning and conducting investigations and applying scientific ideas to demonstrate an understanding of core ideas. The crosscutting concept of patterns is called out as an organizing concept for this disciplinary core idea.

PE DCI	Performance Expectation	Grade Band DCI Connections: Physical Science	Grade Band DCI Connections: Life Science	Grade Band DCI Connections: Earth and Space Science	Science and Engineering Practices	Crosscutting Concepts
HS-PS2.4 PS2.B	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.	PS3.A		ESS1.A ESS1.B ESS1.C ESS2.C ESS3.A	Using Mathematics and Computational Thinking	Patterns

Notes:

UNIT 3, KEPLER'S LAWS

Instructional days: 12

Essential question: How can one use mathematical or computational representations to predict the motion of orbiting objects?

Unit abstract: In this unit of study, students can examine the processes governing the workings of the solar system and universe. The crosscutting concepts of scale, proportion, and quantity are called out as organizing concepts for these disciplinary core ideas. In the space systems performance expectations, students are expected to demonstrate proficiency in using mathematical and computational thinking and to use this practice to demonstrate understanding of core ideas.

PE DCI	Performance Expectation	Grade Band DCI Connections			Science and Engineering Practices	Crosscutting Concepts
		Physical Science	Life Science	Earth and Space Science		
HS-ESS1-4 ESS1.B	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.	PS2.B			Using Mathematics and Computational Thinking	Scale, Proportion, and Quantity

Notes:

UNIT 4, ENERGY — Instructional days: 30

Essential question: How is energy transferred and converted?

Unit abstract: In this unit of study, the disciplinary core idea PS3 is broken down into subcore ideas: definitions of energy, conservation of energy and energy transfer, and the relationship between energy and forces. Energy is understood as a quantitative property of a system that depends on the motion and interactions of matter, and the total change of energy in any system is equal to the total energy transferred into and out of the system. Students also demonstrate their understanding of engineering principles when they design, build, and refine devices associated with the conversion of energy. The crosscutting concepts of cause and effect, systems and systems models, energy and matter, and the influence of science, engineering, and technology on society and the natural world are further developed in the performance expectations associated with PS3. In these performance expectations, students are expected to demonstrate proficiency in developing and using models, planning and carry out investigations, using computational thinking and designing solutions, and they are expected to use these practices to demonstrate understanding of core ideas.

PE DCI	Performance Expectation	Grade Band DCI Connections			Science and Engineering Practices	Crosscutting Concepts
		Physical Science	Life Science	Earth and Space Science		
HS-PS3-2 PS3.A	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 position of particles (objects).	PS1.A PS1.B PS2.B			Developing and Using Models	Energy and Matter
HS-PS3-1 PS3.A PS3.B	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.	PS1.B	LS2.B	ESS1.A ESS2.A	Using Mathematics and Computational Thinking	Systems and System Models
HS-PS3-3*	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.			ESS3.A	Constructing Explanations and Designing Solutions	Energy and Matter
HS-ETS1-1 ETS1.A	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.				Asking Questions and Defining Problems	
HS-ETS1-2 ETS1.C	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.				Constructing Explanations and Designing Solutions	
HS-ETS1-3 ETS1.B	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.				Constructing Explanations and Designing Solutions	
HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.				Using Mathematics and Computational Thinking	Systems and System Models

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Notes:

UNIT 5, PLATE TECTONICS — Instructional days: 12

Essential Question(s):
How and why is the Earth constantly changing?
Why do the continents move?
How do people reconstruct and date events in Earth's planetary history?
How do the major earth systems interact?

Unit abstract: In this unit of study, students can construct explanations for the scales of time over which Earth processes operate. An important aspect of Earth and space sciences involves making inferences about events in Earth's history based on a data record that is increasingly incomplete the farther one goes back in time. A mathematical analysis of radiometric dating is used to comprehend how absolute ages are obtained for the geologic record. Students can develop models and explanations for the ways that feedback among different Earth systems controls the appearance of the Earth's surface. Central to this is the tension between internal systems, which are largely responsible for creating land at Earth's surface (e.g., volcanism and mountain building), and the sun-driven surface systems that tear down land through weathering and erosion. Students are expected to demonstrate proficiency in developing and using models, constructing explanations, and engaging in argument from evidence. The crosscutting concepts of stability and change, energy and matter, and patterns are called out as organizing elements of this unit.

PE DCI	Performance Expectation	Grade Band DCI Connections: Physical Science	Grade Band DCI Connections: Life Science	Grade Band DCI Connections: Earth and Space Science	Science and Engineering Practices	Crosscutting Concepts
HS-ESS2-1 ESS2.A ESS2.B	Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.	PS2B			Developing and Using Models	Stability and Change
HS-ESS2-3 ESS2.A ESS2.B PS4.A	Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.	PS2.B PS3.B PS3.D			Developing and Using Models	Energy and Matter
HS-ESS1-5 ESS1.C ESS2.B PS1.C	Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.	PS3.B		ESS2.A	Engaging in Argument from Evidence	Patterns
HS-ESS2-2 ESS2.A ESS2.D	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.	PS3.B PS4.B	LS2.C LS4.D	ESS3.C	Analyzing and Interpreting Data	Stability and Change

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Notes:

UNIT 6, WAVE PROPERTIES

Instructional days: 28

Essential question: How are waves used to transfer energy and send and store information?

Unit abstract: In this unit of study, students are able to apply understanding of how wave properties can be used to transfer information across long distances, store information, and investigate nature on many scales. The crosscutting concept of cause and effect is highlighted as an organizing concept for these disciplinary core ideas. In the PS3 performance expectations, students are expected to demonstrate proficiency in using mathematical thinking, and to use this practice to demonstrate understanding of the core idea.

PE DCI	Performance Expectation	Grade Band DCI Connections: Physical Science	Grade Band DCI Connections: Life Science	Grade Band DCI Connections: Earth and Space Science	Science and Engineering Practices	Crosscutting Concepts
HS-PS4-1 PS4.A	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.			ESS2.A	Using Mathematics and Computational Thinking	Cause and Effect

Notes:

UNIT 7, ELECTROMAGNETIC RADIATION

Instructional days: 28

Essential questions:
- When and why is it more beneficial to describe electromagnetic radiation using a particle model versus a wave model?
- What effects do different frequencies of electromagnetic radiation have when they interact with matter?
- How are the interactions between waves and matter used to transmit and capture information and energy?
- What are the advantages of using digital transmission and storage of information?

Unit abstract: In this unit of study, students are able to apply understanding of how wave properties and interactions of electromagnetic radiation with matter can transfer information across long distances, store information, and be used to investigate nature on many scales. Models of electromagnetic radiation as either a wave of changing electrical and magnetic fields or as particles are developed and used. Students also demonstrate their understanding of engineering ideas by presenting information about how technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. The crosscutting concepts of systems and system models; stability and change; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are highlighted as organizing concepts. Students are expected to demonstrate proficiency in asking questions, engaging in argument from evidence, and obtaining, evaluating, and communicating information, and they are expected to use these practices to demonstrate understanding of the core ideas.

PE DCI	Performance Expectation	Grade Band DCI Connections: Physical Science	Grade Band DCI Connections: Life Science	Grade Band DCI Connections: Earth and Space Science	Science and Engineering Practices	Crosscutting Concepts
HS-PS4-3 PS4.A PS4.B	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.	PS3.D		ESS1.A ESS2.D	Engaging in Argument from Evidence	Systems and System Models
HSPS4-4 PS4.B	Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.	PS1.C PS3.A PS3.D			Obtaining, Evaluating, and Communicating Information	Cause and Effect
HS-PS4-5* PS3.D PS4.A PS4.B PS4.C	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.	PS3.A			Obtaining, Evaluating, and Communicating Information	Cause and Effect
HS-ETS1-1 ETS1.A	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.				Asking Questions and Defining Problems	
HS-ETS1-3 ETS1.B	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.				Constructing Explanations and Designing Solutions	
HS-PS4-2 PS4.A	Evaluate questions about the advantages of using a digital transmission and storage of information.				Asking Questions and Defining Problems	Stability and Change

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Notes:

UNIT 8, ELECTRICITY AND MAGNETISM

Instructional days: 12

Essential question: How can one explain and predict interactions between objects and within systems of objects?

In this unit of study, the performance expectations support students' understanding of how forces at a distance can be explained by fields, why some materials are attracted to each other while other are not, how magnets or electric currents cause magnetic fields, and how charges or changing magnetic fields cause electric fields. The crosscutting concept of cause and effect is called out as an organizing concept. Students are expected to demonstrate proficiency in planning and conducting investigations and developing and using models.

PE DCI	Performance Expectation	Grade Band DCI Connections: Physical Science	Grade Band DCI Connections: Life Science	Grade Band DCI Connections: Earth and Space Science	Science and Engineering Practices	Crosscutting Concepts
HS-PS2-5 PS2.B PS3.A	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.	PS3.A PS4.B		ESS2.A ESS3.A	Planning and Carrying Out Investigations	Cause and Effect
HS-PS3-5 PS3.C	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.	PS2.B			Developing and Using Models	Cause and Effect

Notes: