DISTRICT OF COLUMBIA
PUBLIC SCHOOLS

High School Physics Scope and Sequence for the

NEXT GENERATION SCIENCE STANDARDS

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A Guide to Reading the DCPS Science Scope and Sequence

In response to the adoption of the Next Generation Science Standards (NGSS)[1] by the State Board of Education in December 2013, the District of Columbia Public Schools (DCPS) Office of Teaching and Learning convened a group of science teachers – the STEM Master Teacher Corps – to develop a new scope and sequence (SAS) for science for grades K-12. The inaugural STEM Master Teacher Corps consisted of the following dedicated educators:

- Gloria Allen – Hardy Middle School
- Erica Banks – Cardozo Education Campus
- Sydney Bergman – School Without Walls High School
- Jessica Buono – DCPS Office of Teaching and Learning
- Megan Fisk – Eastern High School
- Rabiah Harris – Kelly Miller Middle School
- Trilby Hillenbrand – Jefferson Middle School Academy
- Leslie Maddox – Wilson High School
- Amanda Oberski – Ludlow-Taylor Elementary School
- Lola Odukoya – Langdon Education Campus
- Ericka Senegar-Mitchell – McKinley Technology High School
- Stephen Sholtas – Brookland Education Campus
- Molly Smith – Cardozo Education Campus
- Angelique Sykes – Dunbar High School

The principal goal was to reorganize the complex NGSS architecture into instructional units that would make the most sense to teachers.

All scope and sequences begin with a **Grade Level/Course overview** that summarizes what students will learn for the year, followed by a **"School Year at a Glance"** that summarizes the order of the units and a suggested timeline for their implementation. All SAS assume a full year of science for a minimum of 225 minutes per week for all grade levels.

[1] A full copy of the NGSS can be downloaded from the NGSS website at http://www.nextgenscience.org.

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Following the grade level/course overview and year at a glance, each unit is broken out into several sections beginning with the **Disciplinary Core Ideas (DCIs)** and **Crosscutting Concepts** (**"What to Teach"**) and the **Science and Engineering Practices** (**"What Students Do"**) for that unit. This was done to emphasize that the Science and Engineering Practices are the way that students experience the content so that they think, speak, act, and write the way scientists and engineers do. Teachers should also refer to Appendix F of the NGSS to learn more about how these practices are articulated across grade levels.

Student Performance Expectations follow the Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices section of the unit breakdown. Student performance expectations provide a brief explanation of what students who demonstrate understanding of the content are able to do.

Links to the **Common Core State Standards (CCSS) for ELA/Literacy and Mathematics** (including the Standards for Mathematical Practice) are included in every unit breakdown to emphasize the connections between CCSS and the NGSS so that teachers can more readily identify entry points for integration of science across subject areas. Teachers should also refer to the full NGSS document for additional connections to other DCIs and for information about articulation of DCIs across grade levels.

Finally, connections to the ***former*** **DC Science Standards** are included with every unit to serve as an unofficial crosswalk between the NGSS and the former standards. Teachers should be advised that inclusion of these standards does not imply that they are exactly parallel to the NGSS, but rather are related in some way to the Disciplinary Core Ideas, Crosscutting Concepts, and/or Science and Engineering Practices that make up the NGSS Performance Expectation(s) for that unit. More importantly, teachers should know that inclusion of the former standards is not intended for the purpose of continuing to teach with these standards, but rather so that teachers can more readily see how the content in the NGSS differs from that of the former standards.

A list of resources to help teachers plan to teach each unit of the scope and sequence are available in the **digital version** of this document, located on the **Elementary and Secondary Science Educators Pages of the DCPS Educator Portal**[2]. Be sure to check the Educator Portal frequently for subsequent updates to this document.

For more information about the NGSS, please contact James Rountree, Science Curriculum Specialist (e-mail: james.rountree@dc.gov, phone: 202-442-4643).

[2] To access the Educator Portal, visit http://www.educatorportalplus.com.

High School Physics
Overview and Scope and Sequence SY14-15

Course Overview: Physics I is the study of the way the universe works. Students will discover how Newtonian and classical physics can describe and explain the physical world. Students will also examine how modern technologies that have emerged stem from those laws, the electromagnetic spectrum, and knowledge of the atom. The topics covered will include motion, forces, gravity, energy, momentum, waves, sound, light, optics, electricity, and magnetism. Students will bridge old understandings with the new, learning how modern physics has changed our understanding of the physical world, and has afforded us with modern conveniences.

School Year At a Glance

Advisory	Units	Timeline
Advisory 1	Unit 1: Forces in One Dimension Unit 2: Forces in Two Dimensions	9 weeks
Advisory 2	Unit 3: Energy & Motion (Part 1) Unit 4: Energy & Motion (Part 2)	9 weeks
Advisory 3	Unit 5: Electromagnetic Radiation and Sound Unit 6: Electromagnetic Radiation and Light	9 weeks
Advisory 4	Unit 7: Charge and Electricity Unit 8: Magnetism	9 weeks

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Advisory 1

Unit 1: Forces in One Dimension		
What to Teach		**What Students Do**
Disciplinary Core Ideas	**Crosscutting Concepts**	**Science & Engineering Practices**
PS2.A: Forces and Motion • Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-2). • 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-PS2-2), (HS-PS2-3) **ETS1.A: Defining and Delimiting Engineering Problems** • 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. *(Secondary to HS-PS2-3)* **ETS1.C: Optimizing the Design Solution** • 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. *(Secondary to HS-PS2-3)*	**Cause and Effect** • Systems can be designed to cause a desired effect. (HS-PS2-3) **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2)	**Using Mathematics and Computational Thinking** • Use mathematical representations of phenomena to describe explanations. (HS-PS2-2) **Constructing Explanations and Designing Solutions** • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3)
What to Assess:		

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Unit 1: Forces in One Dimension	
Student Performance Expectations	
Students who demonstrate understanding can: **HS-PS2-2.** 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. [Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.] [Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.] **HS-PS2-3.** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* [Clarification Statement: 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 Boundary: Assessment is limited to qualitative evaluation and/or algebraic manipulations.]	
Integrated Common Core State Standards	
For ELA/Literacy **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated questions) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS2-3)	**For Mathematics** **MP.2** Reason abstractly and quantitatively. (HS-PS2-2) **MP.4** Model with mathematics. (HS-PS2-2) **HSN-Q.A.1** Use units as way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; chose and interpret the scale and the origin of graphs and data analysis. (HS-PS2-2) **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-2) **HSN-Q.A.3** Choose level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-2) **HSA-CED.A.1** Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-2) **HSA-CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-PS2-2) **HSA-CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-2)
Connections to *Former* DC Science Standards	
Motion and Forces: P.2.1, P.2.3, P.2.9-10, P.2.13	

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Unit 2: Forces in Two Dimensions		
What to Teach		**What Students Do**
Disciplinary Core Ideas	**Crosscutting Concepts**	**Science & Engineering Practices**
PS2.A: Forces and Motion • Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) • Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-2). • 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-PS2-2), (HS-PS2-3) **ETS1.A: Defining and Delimiting Engineering Problems** • 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. *(Secondary to HS-PS2-3)* **ETS1.C: Optimizing the Design Solution** • 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-	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1) • Systems can be designed to cause a desired effect. (HS-PS2-3) **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2)	**Analyzing and Interpreting Data** • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-PS2-1) **Using Mathematics and Computational Thinking** • Use mathematical representations of phenomena to describe explanations. (HS-PS2-2) **Constructing Explanations and Designing Solutions** • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3) -- ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. (HS-PS2-1) • Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1)

Unit 2: Forces in Two Dimensions		
offs) may be needed. *(Secondary to HS-PS2-3)*		

What to Assess:
Student Performance Expectations

Students who demonstrate understanding can:

HS-PS2-1. 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. [Clarification Statement: 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.] [Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.]

HS-PS2-2. 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. [Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.] [Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.]

HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* [Clarification Statement: 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 Boundary: Assessment is limited to qualitative evaluation and/or algebraic manipulations.]

Integrated Common Core State Standards

For ELA/Literacy	For Mathematics
RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS2-1) **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem. (HS-PS2-1) **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated questions) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS2-3)	**MP.2** Reason abstractly and quantitatively. (HS-PS2-1) (HS-PS2-2) **MP.4** Model with mathematics. (HS-PS2-1) (HS-PS2-2) **HSN-Q.A.1** Use units as way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; chose and interpret the scale and the origin of graphs and data analysis. (HS-PS2-1) (HS-PS2-2) **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1) (HS-PS2-2) **HSN-Q.A.3** Choose level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1) (HS-PS2-2) **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1) **HSA-SSE.B.3** Choose and produce an equivalent form of an

Unit 2: Forces in Two Dimensions	
WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1)	expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1) **HSA-CED.A.1** Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1) (HS-PS2-2) **HSA-CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-PS2-1) (HS-PS2-2) **HSA-CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1) (HS-PS2-2) **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1) **HSS-ID.A.1** Represent data with plots on the real number line (dot plots, histograms, and box plots). (HS-PS2-1)
Connections to *Former* DC Science Standards	
Motion and Forces: P.2.1, P.2.3, P.2.9-10, P.2.13 **Scientific Thinking and Inquiry:** P.1.8	

Advisory 2

Unit 3: Energy and Motion (Part 1)		
What to Teach		**What Students Do**
Disciplinary Core Ideas	**Crosscutting Concepts**	**Science & Engineering Practices**
PS3.A: Definitions of Energy • 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- PS3-1), (HS-PS3-2) • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) (HS-PS3-3) • These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as either motions of particles or energy 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-PS3-2) **PS3.B: Conservation of Energy and Energy**	**Systems and System Models** • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1) **Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS3-3) • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2) -- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and	**Developing and Using Models** • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2) **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1) **Constructing Explanations and Designing Solutions** • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS- PS3-3)

Unit 3: Energy and Motion (Part 1)		
Transfer • 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-PS3-1) • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1) • 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-PS3-1) • The availability of energy limits what can occur in any system. (HS-PS3-1) **PS3.D: Energy in Chemical Processes** • Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3) **ETS1.A: Defining and Delimiting Engineering Problems** • Criteria and constraints also include satisfying any requirements set by	engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3) --- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)	

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Unit 3: Energy and Motion (Part 1)		
society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated such that one can tell if a given design meets them. *(Secondary to HS-PS3-3)*		

What to Assess: ***Student Performance Expectations***
Students who demonstrate understanding can: **HS-PS3-1.** 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. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: 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.] **HS-PS3-2.** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields. [Clarification Statement: 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.] **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.* [Clarification Statement: 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 constrains could include the use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]

Integrated Common Core State Standards	
For ELA/Literacy **WHST.9-12.7** Construct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS3-3) **SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence to	**For Mathematics** **MP.2** Reason abstractly and quantitatively. (HS-PS3-1) (HS-PS3-2) (HS-PS3-3) **MP.4** Model with mathematics. (HS-PS3-1) (HS-PS3-2) (HS-PS3-3) **HSN-Q.A.1** Use units as way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; chose and interpret the scale and the origin of graphs and data analysis. (HS-PS3-1) (HS-PS3-3) **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS3-1) (HS-PS3-3)

Unit 3: Energy and Motion (Part 1)	
add interest. (HS-PS3-1) (HS-PS3-2)	**HSN-Q.A.3** Choose level of accuracy appropriate to limitations on measurement when reporting quantities**.** (HS-PS3-1) (HS-PS3-3)

Connections to *Former* DC Science Standards
Conservation of Energy and Momentum: P.3.1, P.3.4, P.3.8, P.3.10 **Scientific Thinking and Inquiry:** P.1.4

Unit 4: Energy & Motion (Part 2)		
What to Teach		What Students Do
Disciplinary Core Ideas	Crosscutting Concepts	Science & Engineering Practices
PS3.A: Definitions of Energy • 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- PS3-1), (HS-PS3-2) • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) • These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as either motions of particles or energy 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-PS3-2) **PS3.B: Conservation of Energy and Energy Transfer**	**Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4) • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS- PS3-1) **Energy and Matter** • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2) --- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)	**Developing and Using Models** • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2) **Planning and Carrying Out Investigations** • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS3-4) **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)

Unit 4: Energy & Motion (Part 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-PS3-1) • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4) • 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-PS3-1) • The availability of energy limits what can occur in any system. (HS-PS3-1) • Uncontrolled systems always evolve toward more stable states – that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4) **PS3.D: Energy in Chemical Processes** • Although energy cannot be destroyed, it can be converted to less useful forms—for example, to		

Unit 4: Energy & Motion (Part 2)

thermal energy in the surrounding environment. (HS-PS3-4)		

What to Assess:
Student Performance Expectations

Students who demonstrate understanding can:

HS-PS3-1. 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. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: 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.]

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields. [Clarification Statement: 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.]

HS-PS3-4. 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). [Clarification Statement: 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 of difference temperatures to water. [Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.]

Integrated Common Core State Standards

For ELA/Literacy	For Mathematics
RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS3-4) **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS3-3) **WHST.9-12.8** Gather relevant information from multiple authoritative print and digital sources, using advances searches effectively;	**MP.2** Reason abstractly and quantitatively. (HS-PS3-1) (HS-PS3-2) (HS-PS3-4). **MP.4** Model with mathematics. (HS-PS3-1) (HS-PS3-2) (HS-PS3-4). **HSN-Q.A.1** Use units as way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; chose and interpret the scale and the origin of graphs and data analysis. (HS-PS3-1) **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS3-1) **HSN-Q.A.3** Choose level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS3-1)

Unit 4: Energy & Motion (Part 2)	
assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS3-4) **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS3-4) **SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS3-1) (HS-PS3-2)	

Connections to *Former* DC Science Standards
Motion and Forces: P.2.5, P.2.8 **Conservation of Energy and Momentum:** P.3.9

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Advisory 3

<table>
<tr><th colspan="3">Unit 5: Electromagnetic Radiation and Sound</th></tr>
<tr><th colspan="2">What to Teach</th><th>What Students Do</th></tr>
<tr><th>Disciplinary Core Ideas</th><th>Crosscutting Concepts</th><th>Science & Engineering Practices</th></tr>
<tr>
<td>PS3.D: Energy in Chemical Processes
Solar cells are human-made devices that likewise capture the sun’s energy and produce electrical energy. (Secondary to HS-PS4-5)
PS4.A: Wave Properties
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-PS4-1)
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-PS4-2), (HS- PS4-5)
[From the 3–5 grade band endpoints] 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</td>
<td>Cause and Effect
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-1)
Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS4-4)
Systems can be designed to cause a desired effect. (HS-PS4-5)
Systems and System Models
Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions – including energy, matter, and information flows—within and between systems at different scales. (HS-PS4-3)
Stability and Change
Systems can be designed for greater or lesser stability. (HS-PS4-2)

Connections to Engineering, Technology, and Applications of Science</td>
<td>Asking Questions and Defining Problems
Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. (HS- PS4-2)
Using Mathematics and Computational Thinking
Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS4-1)
Engaging in Argument from Evidence
Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-PS4-3)
Obtaining, Evaluating, and Communicating Information
Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4)
Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally,</td>
</tr>
</table>

Unit 5: Electromagnetic Radiation and Sound		
mixed up.) (HS-PS4-3) **PS4.B: Electromagnetic Radiation** • 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-PS4-3) • 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-PS4-4) • Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5) **PS4.C: Information Technologies and Instrumentation** • 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, and scanners) and in scientific research. They are essential tools for producing,	**Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D). (HS- PS4-5) **Influence of Engineering, Technology, and Science on Society and the Natural World** • Modern civilization depends on major technological systems. (HS-PS4-2), (HS- PS4-5) • Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS- PS4-2)	graphically, textually, and mathematically). (HS- PS4-5) -- -- ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate the theory is generally modified in light of this new evidence. (HS-PS4-3)

Unit 5: Electromagnetic Radiation and Sound		
transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)		

What to Assess:
Student Performance Expectations

Students who demonstrate understanding can:

HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [Clarification Statement: Examples of data could include electromagnetic radiation travelling in a vacuum and glass, sound waves travelling through air and water, and seismic waves travelling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]

HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information. [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]

HS-PS4-3. 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. [Clarification Statement: 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, diffractions, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.]

HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. [Clarification Statement: Emphasis is on the idea that photons associated with difference 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.] [Assessment Boundary: Assessment is limited to qualitative descriptions.]

HS-PS4-5. 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.* [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]

Integrated Common Core State Standards

For ELA/Literacy	For Mathematics
RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-PS4-2), (HS-PS4-3), (HS-PS4-	**MP.2** Reason abstractly and quantitatively. (HS-PS4-1), (HS-PS4-3) **MP.4** Model with mathematics. (HS-PS4-1) **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms

Unit 5: Electromagnetic Radiation and Sound	
4) **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS4-2), (HS-PS4-3), (HS-PS4-4) **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS4-1), (HS-PS4-4) **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-PS4-2), (HS-PS4-3), (HS-PS4-4) **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS4-5) **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS4-4)	of its context. (HS-PS4-1), (HS-PS4-3) **HSA-SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-1), (HS-PS4-3) **HSA.CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1), (HS-PS4-3)
Connections to *Former* DC Science Standards	
Waves: P.6.2, P.6.4-6, P.6.8, P.6.12, P.6.14	

Unit 6: Electromagnetic Radiation and Light		
What to Teach		What Students Do
Disciplinary Core Ideas	Crosscutting Concepts	Science & Engineering Practices
PS3.D: Energy in Chemical Processes • Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. *(Secondary to HS-PS4-5)* **PS4.A: Wave Properties** • 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-PS4-1) • 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-PS4-2), (HS-PS4-5) • [From the 3–5 grade band endpoints] 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	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-1) • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS4-4) • Systems can be designed to cause a desired effect. (HS-PS4-5) **Systems and System Models** • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions – including energy, matter, and information flows—within and between systems at different scales. (HS-PS4-3) **Stability and Change** • Systems can be designed for greater or lesser stability. (HS-PS4-2)	**Asking Questions and Defining Problems** • Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. (HS- PS4-2) **Using Mathematics and Computational Thinking** • Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS4-1) **Engaging in Argument from Evidence** • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-PS4-3) **Obtaining, Evaluating, and Communicating Information** • Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4) • Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally,

Unit 6: Electromagnetic Radiation and Light		
mixed up.) (HS-PS4-3) **PS4.B: Electromagnetic Radiation** • 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-PS4-3) • 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-PS4-4) • Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5) **PS4.C: Information Technologies and Instrumentation** • 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, and scanners) and in scientific research. They are essential tools for producing,	--- ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D). (HS- PS4-5) **Influence of Engineering, Technology, and Science on Society and the Natural World** • Modern civilization depends on major technological systems. (HS-PS4-2), (HS- PS4-5) • Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS- PS4-2)	graphically, textually, and mathematically). (HS- PS4-5) --- ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate the theory is generally modified in light of this new evidence. (HS- PS4-3)

Unit 6: Electromagnetic Radiation and Light		
transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)		

What to Assess: ***Student Performance Expectations***
Students who demonstrate understanding can: **HS-PS4-1.** Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [Clarification Statement: Examples of data could include electromagnetic radiation travelling in a vacuum and glass, sound waves travelling through air and water, and seismic waves travelling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.] **HS-PS4-2.** Evaluate questions about the advantages of using a digital transmission and storage of information. [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.] **HS-PS4-3.** 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. [Clarification Statement: 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, diffractions, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.] **HS-PS4-4.** Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. [Clarification Statement: Emphasis is on the idea that photons associated with difference 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.] [Assessment Boundary: Assessment is limited to qualitative descriptions.] **HS-PS4-5.** 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.* [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [Assessment Boundary: Limited to qualitative information. Assessments do not include band theory.]

Integrated Common Core State Standards	
For ELA/Literacy **RST.9-10.8** Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-PS4-2), (HS-PS4-3), (HS-PS4-4)	**For Mathematics** **MP.2** Reason abstractly and quantitatively. (HS-PS4-1), (HS-PS4-3) **MP.4** Model with mathematics. (HS-PS4-1) **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms

Unit 6: Electromagnetic Radiation and Light	
RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS4-2), (HS-PS4-3), (HS-PS4-4) **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS4-1), (HS-PS4-4) **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-PS4-2), (HS-PS4-3), (HS-PS4-4) **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS4-5) **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS4-4)	of its context. (HS-PS4-1), (HS-PS4-3) **HSA-SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-1), (HS-PS4-3) **HSA.CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1), (HS-PS4-3)
Connections to *Former* DC Science Standards	
Waves: P.6.8, P.6.12, P.6.14 **Electromagnetism:** P.7.13	

Advisory 4

Unit 7: Charge and Electricity		
What to Teach		**What Students Do**
Disciplinary Core Ideas	**Crosscutting Concepts**	**Science & Engineering Practices**
PS2.B: Types of Interactions • 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-PS2-4) • 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-PS2-4), (HS-PS2-5) **PS3.A: Definitions of Energy** • "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. *(Secondary to HS-PS2-5)* **PS3.C: Relationship Between Energy and Forces** • When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS2-4) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-5) • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS3-5)	**Planning and Carrying Out Investigations** • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS2-5) **Using Mathematics and Computational Thinking** • Use mathematical representations of phenomena to describe explanations. (HS-PS2-4) **Developing and Using Models** • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS- PS3-5) --- ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. (HS-PS2-4)

Unit 7: Charge and Electricity		
		• Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-4)

What to Assess: ***Student Performance Expectations***
Students who demonstrate understanding can: **HS-PS2-4.** Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. [Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.] [Assessment Boundary: Assessment is limited to systems with two objects.] **HS-PS2-5.** 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. [Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.] **HS-PS3-5.** 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. [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two changes of opposite polarity are near each other.] [Assessment Boundary: Assessment is limited to systems containing two objects.]

Integrated Common Core State Standards	
For ELA/Literacy **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS2-5) (HS-PS3-5) **WHST.9-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS2-5) (HS-PS3-5) **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-5) (HS-PS3-5)	**For Mathematics** **MP.2** Reason abstractly and quantitatively. (HS-PS2-4) (HS-PS3-5) **MP.4** Model with mathematics. (HS-PS2-4) (HS-PS3-5) **HSN-Q.A.1** Use units as way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; chose and interpret the scale and the origin of graphs and data analysis. (HS-PS2-4) (HS-PS2-5) (HS-PS3-5) **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-4) (HS-PS2-5) **HSN-Q.A.3** Choose level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-4) (HS-PS2-5) **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. (HS-PS2-4) **HSA-SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity

Unit 7: Charge and Electricity	
SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS3-5)	represented by the expression. (HS-PS2- 4)

Connections to *Former* DC Science Standards
Electromagnetism: P.7.1, P.7.3, P.7.17-18

Unit 8: Magnetism		
What to Teach		What Students Do
Disciplinary Core Ideas	Crosscutting Concepts	Science & Engineering Practices
PS2.B: Types of Interactions • 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-PS2-4) • 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-PS2-4), (HS-PS2-5) **PS3.A: Definitions of Energy** • "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. *(Secondary to HS-PS2-5)* **PS3.C: Relationship Between Energy and Forces** • When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS2-4) **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-5) • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS3-5)	**Planning and Carrying Out Investigations** • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS2-5) **Using Mathematics and Computational Thinking** • Use mathematical representations of phenomena to describe explanations. (HS-PS2-4) **Developing and Using Models** • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS- PS3-5) --- ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. (HS-PS2-4)

Unit 8: Magnetism		
		Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-4)

What to Assess: *Student Performance Expectations*
Students who demonstrate understanding can: **HS-PS2-4.** Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. [Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.] [Assessment Boundary: Assessment is limited to systems with two objects.] **HS-PS2-5.** 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. [Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.] **HS-PS3-5.** 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. [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two changes of opposite polarity are near each other.] [Assessment Boundary: Assessment is limited to systems containing two objects.]

Integrated Common Core State Standards	
For ELA/Literacy **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS2-5) (HS-PS3-5) **WHST.9-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS2-5) (HS-PS3-5) **WHST.9-12.9** Draw evidence from informational texts to support	**For Mathematics** **MP.2** Reason abstractly and quantitatively. (HS-PS2-4) (HS-PS3-5) **MP.4** Model with mathematics. (HS-PS2-4) (HS-PS3-5) **HSN-Q.A.1** Use units as way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; chose and interpret the scale and the origin of graphs and data analysis. (HS-PS2-4) (HS-PS2-5) (HS-PS3-5) **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-4) (HS-PS2-5) **HSN-Q.A.3** Choose level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-4) (HS-PS2-5) **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. (HS-PS2-4) **HSA-SSE.B.3** Choose and produce an equivalent form of an

Unit 8: Magnetism	
analysis, reflection, and research. (HS-PS2-5) (HS-PS3-5) **SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS3-5)	expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2- 4)

Connections to *Former* DC Science Standards
Electromagnetism: P.7.11, P.7.14, P.7.19 **Scientific Thinking and Inquiry:** P.1.8

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