



Unit Ideas and Associated NGSS Standards

Many of the lessons and activities may be completed as individual stand-alone activities, as sets of activities (see Prior Knowledge & Skills category in each lesson), or as complete classroom units. The below are some suggested units but many other combinations exist since the curriculum was designed to be flexible to meet the needs of a variety of courses and instructional goals. The following pages contain NGSS information for each unit, including performance expectations students are working toward meeting by the unit's completion.

<p>Unit A: Space and Engineering</p> <ul style="list-style-type: none"> • Using Spectral Data to Explore Saturn and Titan • Goldilocks and the Three Planets • Designer: What's Trending Hot? Or ⇒ Planet Designer: Kelvin Climb* • Planet Designer: Martian Makeover • Planet Designer: Retro Planet Red* • Building a Fancy Spectrograph • A Spectral Mystery • Designing an Open Spectrograph <i>And/or</i> ⇒ Designing a Spectroscopy Mission Planet* 	<p>Unit B: Light and Engineering</p> <ul style="list-style-type: none"> • Graphing the Rainbow • Building a Fancy Spectrograph • Using a Fancy Spectrograph • Designing an Open Spectrograph <i>And/or</i> ⇒ Designing a Spectroscopy Mission*
<p>Unit C: Light</p> <ul style="list-style-type: none"> • Graphing the Rainbow • Building a Fancy Spectrograph • Using a Fancy Spectrograph 	<p>Unit D: Patterns and Graphing</p> <ul style="list-style-type: none"> • Patterns and Fingerprints • Graphing the Rainbow • Using Spectral Data to Explore Saturn and Titan • Goldilocks and the Three Planets • Marvelous Martian Mineralogy • Star Light, Star Bright • Solving a Mixed Up Problem • Enceladus, I Barely Knew You

* Denotes recommended only for high school grades

Unit A: Space and Engineering

MS. Waves and Electromagnetic Radiation		
Students who demonstrate understanding can:		
MS-PS4-2* . Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Using Mathematical and Computational Thinking Mathematical and computational thinking at the 6-8 level builds on K-5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.</p> <ul style="list-style-type: none"> -Use mathematical representations to decide and/or support scientific conclusions and design solutions. <p>Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods.</p> <ul style="list-style-type: none"> -Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. 	<p>PS4.B: Electromagnetic Radiation</p> <ul style="list-style-type: none"> - When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2) - A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2) - However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-3) 	<p>Patterns</p> <ul style="list-style-type: none"> - Graphs and charts can be used to identify patterns in data.

*Working towards MS-PS4-2

MS. Space Systems

Students who demonstrate understanding can:

MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Analyzing and Interpreting Data Analyze data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. - Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3)</p>	<p>ESS1.B: Earth and the Solar System - The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-3)</p>	<p>Patterns - Patterns can be used to identify cause-and-effect relationships.</p> <p>Systems and System Models - Models can be used to represent systems and their interactions.</p>

MS. Engineering Design

Students who demonstrate understanding can:

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Developing and Using Models Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none">- Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4). <p>Analyzing and Interpreting Data Analyze data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.</p> <ul style="list-style-type: none">- Analyze and interpret data to determine similarities and differences in findings.	<p>ETS1.A: Defining and Delimiting Engineering Problems</p> <ul style="list-style-type: none">- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific knowledge that are likely to limit possible solutions. <p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none">- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.- Models of all kinds are important for testing solutions. (MS-ETS1-4)	<p>Influences of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none">- The use of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research and by differences in such factors as climate, natural resources, and economic conditions.

HS. Waves and Electromagnetic Radiation

Students who demonstrate understanding can:

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.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Using Mathematical and Computational Thinking Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</p> <ul style="list-style-type: none">- Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. <p>Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9-12 builds on K-8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.</p> <ul style="list-style-type: none">- 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, graphically, textually, and mathematically).	<p>PS4.B: Electromagnetic Radiation</p> <ul style="list-style-type: none">- 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, and gamma rays) can ionize atoms and cause damage to living cells.	<p>Systems and System Models</p> <ul style="list-style-type: none">- 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. Engineering Design

Students who demonstrate understanding can:

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Using Mathematics and Computational Thinking Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</p> <ul style="list-style-type: none">- Using mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. <p>Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.</p> <ul style="list-style-type: none">- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	<p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none">- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. <p>ETS1.C: Optimizing the Design Solution</p> <ul style="list-style-type: none">- 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-ETS1-2)	<p>Systems and System Models</p> <ul style="list-style-type: none">- 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.

Unit B: Light and Engineering

MS. Waves and Electromagnetic Radiation		
Students who demonstrate understanding can:		
MS-PS4-2*: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Using Mathematical and Computational Thinking</p> <p>Mathematical and computational thinking at the 6-8 level builds on K-5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.</p> <ul style="list-style-type: none"> -Use mathematical representations to decide and/or support scientific conclusions and design solutions. 	<p>PS4.B: Electromagnetic Radiation</p> <ul style="list-style-type: none"> - When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2) - A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2) - However, because light can travel through space, it cannot be a matter wave, like sound or water waves. 	<p>Patterns</p> <ul style="list-style-type: none"> - Graphs and charts can be used to identify patterns in data. <p>Influences of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> - Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations.

*Working towards MS-PS4-2

MS. Engineering Design

Students who demonstrate understanding can:

HS-ETS1-1*. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

HS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Developing and Using Models Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> - Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. <p>Engaging in Argument from Evidence Engaging in argument from evidence in 6-8 builds on K-5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.</p> <ul style="list-style-type: none"> - Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. 	<p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none"> - A solution needs to be tested, and then modified on a basis of the test results, in order to improve it. (MS-ETS1-4) - Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. - Models of all kinds are important for testing solutions. (MS-ETS1-4) 	<p>Influences of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> - The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

*Working towards MS-ETS1-1

HS. Engineering Design

Students who demonstrate understanding can:

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3*. 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.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Using Mathematics and Computational Thinking Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</p> <ul style="list-style-type: none">- Using mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.	<p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none">- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.	<p>Systems and System Models</p> <ul style="list-style-type: none">- 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.

<p>Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.</p> <ul style="list-style-type: none"> - Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) - Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3) 	<p>ETS1.C: Optimizing the Design Solution</p> <ul style="list-style-type: none"> - 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-ETS1-2) 	
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*Working towards HS-ETS1-3

Unit C: Light

MS. Waves and Electromagnetic Radiation

Students who demonstrate understanding can:

MS-PS4-2*: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Scientific Knowledge is Based on Empirical Evidence</p> <ul style="list-style-type: none"> - Scientific knowledge is based upon logical and conceptual connections between evidence and explanations. 	<p>PS4.B: Electromagnetic Radiation</p> <ul style="list-style-type: none"> - When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2) - A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2) - However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-3) 	<p>Patterns</p> <ul style="list-style-type: none"> - Graphs and charts can be used to identify patterns in data. <p>Influences of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> - Technologies extended the measurement, exploration, modeling, and computational capacity of scientific investigations.

*Working towards MS-PS4-2

Unit D: Patterns and Graphing

MS. Space Systems

Students who demonstrate understanding can:

MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Analyzing and Interpreting Data Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. - Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3)</p>	<p>ESS1.B: Earth and the Solar System - The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-3)</p>	<p>Patterns - Patterns can be used to identify cause-and-effect relationships.</p> <p>Systems and System Models - Models can be used to represent systems and their interactions.</p>

MS. Waves and Electromagnetic Radiation

Students who demonstrate understanding can:

MS-PS4-2*. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods.</p> <ul style="list-style-type: none"> -Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. <p>Scientific Knowledge is Based on Empirical Evidence</p> <ul style="list-style-type: none"> - Science knowledge is based on logical and conceptual connections between evidence and explanations. 	<p>PS4.B: Electromagnetic Radiation</p> <ul style="list-style-type: none"> - When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2) - A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2) - However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-3) 	<p>Patterns</p> <ul style="list-style-type: none"> - Graphs and charts can be used to identify patterns in data. <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> - Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations.

*Working towards MS-PS4-2