



Park Hill School District

Building Successful Futures • Each Student • Every Day

High School Physics Curriculum

Course Description: This course emphasizes the conceptual role physics plays in everyday life, thus helping students better understand the scientific issues affecting society. Topics of study include force & motion, conservation of momentum & energy, and the wave nature of matter with applications to sound, light and electricity.

Scope and Sequence:

Timeframe	Unit	Instructional Topics
8 Weeks	Motion	Topic 1: Visual Representation of Motion Topic 2: Uniform Acceleration and Newton's Laws Topic 3: Gravity and Uniform Circular Motion
4-6 Weeks	Conservation	Topic 1: Conservation of Energy Topic 2: Conservation of Momentum Topic 3: Science/Consumer Skills
4 Weeks	Waves	Topic 1: Properties of Waves and Interactions Topic 2: $v = \lambda f$

Unit 1: Motion

Subject: Physics

Grade: 10-12

Name of Unit: Motion

Length of Unit: 8 weeks

Overview of Unit: Motion explores the application of Newton's laws and the kinematics equations to describe how and why a macroscopic object moves.

Priority Standards for unit:

- 9-12.PS2.B.1 Use mathematical representations of Newton's Law of Gravitation to describe and predict the gravitational forces between objects. [Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational fields.]
- 9-12.PS2.A.1 Analyze data to support and verify the concepts expressed by Newton's 2nd law of motion, as it 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 graph 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.]
- 9-12.ESS1.B.1 Use Kepler's Law to predict the motion of orbiting objects in the solar system. [Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons]
- AP Physics 1-3.A.1.3 The student is able to analyze experimental data describing the motion of an object and is able to express the results of the analysis using narrative, mathematical, and graphical representations.

Supporting Standards for unit:

- 9-12.ETS1.A.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.
- 9-12.ETS1.B.2 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 System relevant to the problem.
- AP Physics 1-3.A.1. The student is able to express the motion of an object using narrative, mathematical, and graphical representations.
- ISTE - INNOVATIVE DESIGNER.4: Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions.
- ISTE - COMPUTATIONAL THINKER.5: Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.

- TT.AB.J.12: Students will recognize unfairness on the individual level (e.g., biased speech) and injustice at the institutional or systemic level (e.g., discrimination).
- TT.AB.J.13: Students will analyze the harmful impact of bias and injustice on the world, historically and today.

Unwrapped Concepts (Students need to know)	Unwrapped Skills (Students need to be able to do)	Bloom's Taxonomy Levels	Webb's DOK
Mathematical representations of Newton's Law of Gravitation to describe and predict the gravitational forces between objects	Use	Apply	3
Data to support and verify the concepts expressed by Newton's 2nd law of motion, as it describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration	Analyze	Analyze	3
Use uniform circular motion to predict the motion of orbiting objects in the solar system	Use	Understand	3
Experimental data describing the motion of an object and is able to express the results of the analysis using narrative, mathematical, and graphical representations.	Analyze	Analyze	4

Essential Questions:

1. How do we visually represent the motion of an object and how do we interpret those visuals?
2. How do Newton's laws of motion predict and describe why an object moves?
3. How do we predict and describe how an object moves?

Enduring Understanding/Big Ideas:

1. There are several methods for representing the motion of an object. Examples include: motion diagrams and position vs. time graphs. Students should be able to describe the motion of the object in words based on the visuals used.
2. Newton's Laws of motion give us a model for how objects interact with each other.

3. The Kinematics equations give us a model we can manipulate to describe and predict how an object will be moving at any point in time.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
<p>Slope Area Directly Related Inversely Related Mass Radius Circumference Horizontal Vertical x/y axis Coefficient Perpendicular Parallel Sin, Cos, Tan (basic trig functions) ratio</p>	<p>Vector Scalar Displacement Velocity Acceleration Force Inertia Static Kinetic Normal Base Units</p>

Topic 1: Visual Representation of Motion

Engaging Experience 1

Title: Graph Matching

Suggested Length of Time: 2 blocks

Standards Addressed

Priority:

- AP Physics 1-3.A.1.3 The student is able to analyze experimental data describing the motion of an object and is able to express the results of the analysis using narrative, mathematical, and graphical representations.

Supporting:

- 9-12.ETS1.A.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.
- 9-12.ETS1.B.2 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 System relevant to the problem.
- AP Physics 1-3.A.1. The student is able to express the motion of an object using narrative, mathematical, and graphical representations.
- ISTE - COMPUTATIONAL THINKER.5: Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.

Detailed Description/Instructions: Students will be able to match and describe with words position vs time, velocity vs. t , and acceleration vs. time graphs. Students will also be able to produce graphs from a description of an object's motion. This could include the graph matching lab for the labquests, graph matching games, the motion man simulation on PHET, collecting data with stopwatches and meter sticks, etc.

Bloom's Levels: Apply

Webb's DOK: 3/4

Topic 2: Uniform Acceleration and Newton's Laws

Engaging Experience 1

Title: Projectile Motion

Suggested Length of Time: 1-2 blocks

Standards Addressed

Priority:

- 9-12.PS2.B.1 Use mathematical representations of Newton's Law of Gravitation to describe and predict the gravitational forces between objects. [Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational fields.]
- 9-12.PS2.A.1 Analyze data to support and verify the concepts expressed by Newton's 2nd law of motion, as it 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 graph 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.]
- AP Physics 1-3.A.1.3 The student is able to analyze experimental data describing the motion of an object and is able to express the results of the analysis using narrative, mathematical, and graphical representations.

Supporting:

- AP Physics 1-3.A.1. The student is able to express the motion of an object using narrative, mathematical, and graphical representations.

Detailed Description/Instructions: Students should apply their knowledge of projectile problems. Possibilities include the rocket activity and the bulls eye activity (projectile launchers).

Bloom's Levels: Apply

Webb's DOK: 3/4

Topic 3: Gravity and Uniform Circular Motion

Engaging Experience 1

Title: Finnish Fling

Suggested Length of Time: 1 Block

Standards Addressed

Priority:

- 9-12.PS2.A.1 Analyze data to support and verify the concepts expressed by Newton's 2nd law of motion, as it describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

Supporting:

- 9-12.ETS1.A.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.
- AP Physics 1-3.A.1. The student is able to express the motion of an object using narrative, mathematical, and graphical representations

Detailed Description/Instructions: The goal is to determine the minimum speed the Finnish fling needs to spin at in order to keep the passengers plastered to the wall. This is typically done as a whole class guided problem where the students work through it in pairs or small groups and the teacher scaffolds the class along the way. For regular physics the problem is broken down into multiple parts, the student is not expected to be able to solve the problem from scratch.

Bloom's Levels: Apply

Webb's DOK: 3/4

Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.)

Students will perform a lab to determine the acceleration due to gravity near the Earth's surface. This could include motion equations, graphs, circular motion, and forces.

Students will perform a lab to determine either; the magnitude of the frictional force keeping a quarter on top of a spinning turntable or find the coefficient of static friction between the quarter and the turntable. Another possibility would be to find coefficients of friction between blocks and the lab tables (or tires and the road) along with applications to incline planes.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Visual Representation of Motion	Graph Matching	Students will be able to match and describe with words position vs time, velocity vs. t, and acceleration vs. time graphs. Students will also be able to produce graphs from a description of an object's motion. This could include the graph matching lab for the labquests, graph matching games, the motion man simulation on PHET, collecting data with stopwatches and meter sticks, etc.	2 Blocks
Uniform Acceleration and Newton's Laws	Projectile Motion	Students should apply their knowledge of projectile problems. Possibilities include the rocket activity and the bulls eye activity (projectile launchers).	1-2 Blocks
Gravity and Uniform Circular Motion	Finnish Fling	The goal is to determine the minimum speed the Finnish fling needs to spin at in order to keep the passengers plastered to the wall. This is typically done as a whole class guided problem where the students work through it in pairs or small groups and the teacher scaffolds the class along the way. For regular physics the problem is broken down into multiple parts, the student is not expected to be able to solve the problem from scratch.	1 Block

Unit 2: Conservation

Subject: Physics

Grade: 10-12

Name of Unit: Conservation

Length of Unit: 4-6 Weeks

Overview of Unit: The Laws of Conservation of energy and momentum are applied to a variety of real-world situations.

Priority Standards for unit:

- 9-12.PS2.A.2 Use mathematical representations to support and verify the concepts 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.]
- 9-12.PS2.A.3 Apply scientific principles of motion and momentum 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.]
- 9-12.PS3.A.1 Create a computational model to calculate the change in the energy of one component in a system when the changes in energy are known. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.]
- 9-12.PS3.A.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 constraints could include use of renewable energy forms and efficiency.]
- 9-12.PS3.B.1 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 at different temperatures to water.]

Supporting Standards for unit:

- 9-12.ETS1.A.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.
- 9-12.ETS1.B.2 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 System relevant to the problem.
- AP Physics 1-3.A.1. The student is able to express the motion of an object using narrative, mathematical, and graphical representations.
- ISTE-DIGITAL CITIZEN.2: Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.
- ISTE - KNOWLEDGE COLLECTOR.3: Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.
- ISTE - INNOVATIVE DESIGNER.4: Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions.
- ISTE - COMPUTATIONAL THINKER.5: Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.
- ISTE - CREATIVE COMMUNICATOR.6: Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.
- TT.AB.J.12: Students will recognize unfairness on the individual level (e.g., biased speech) and injustice at the institutional or systemic level (e.g., discrimination).
- TT.AB.J.13: Students will analyze the harmful impact of bias and injustice on the world, historically and today.

Unwrapped Concepts (Students need to know)	Unwrapped Skills (Students need to be able to do)	Bloom's Taxonomy Levels	Webb's DOK
Mathematical representations to support and verify the concepts that the total momentum of a system of objects is conserved when there is no net force on the system.	Use	Understand	2
Scientific principles of motion and momentum to evaluate a device	Apply	Evaluate	4

that minimizes the force on a macroscopic object during a collision.			
A computational model to calculate the change in the energy of one component in a system when the changes in energy are known.	Create	Understand	3
A device that works within a given constraints to convert one form of energy into another form of energy	Design	Apply	2
A device that works within a given constraints to convert one form of energy into another form of energy	Build	Apply	3
A device that works within a given constraints to convert one form of energy into another form of energy	Refine	Evaluate	3
Conceptual understanding of conservation of energy and equilibrium concepts and how they relate to Thermodynamics and the internal energy of a system.	Apply	Understand	3

Essential Questions:

1. How do you know when to apply conservation of mechanical energy?
2. How do you know when to apply conservation of linear momentum?
3. Why is it important to be able to think critically while consuming science information (outside of the classroom and later in life), and how do you know if the information is valid?

Enduring Understanding/Big Ideas:

1. Students are able to identify the system and when mechanical energy is conserved from one point in time to another.
2. Students are able to identify the system and when linear momentum is conserved from one point in time to another.
3. Students know to check multiples sources, think critically for themselves, go to the original research from the experts in the field, and potentially conduct small experiments for themselves.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
Conservation Density Nucleus Chemical potential energy	Momentum Impulse Kinetic Energy Potential Energy Mechanical Energy Electric Potential Energy Elastic Potential Energy Work Internal (Thermal) Energy Pressure Buoyancy Elastic Inelastic Collision Vacuum

Topic 1: Conservation of Energy

Engaging Experience 1

Title: Mechanical Energy and Work

Suggested Length of Time: 1 block

Standards Addressed

Priority:

- 9-12.PS3.A.1 Create a computational model to calculate the change in the energy of one component in a system when the changes in energy are known.
[Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.]
- 9-12.PS3.A.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 constraints could include use of renewable energy forms and efficiency.]

Supporting:

- AP Physics 1-3.A.1. The student is able to express the motion of an object using narrative, mathematical, and graphical representations.

Detailed Description/Instructions: Apply the ideas of ME and W to a computer simulation like line rider. Other possibilities could include PHET simulations or other games.

Bloom's Levels: Apply

Webb's DOK: 3

Topic 2: Conservation of Momentum

Engaging Experience 1

Title: Applying Conservation of Momentum and the Impulse Momentum Theorem to everyday life

Suggested Length of Time: 2-4 blocks

Standards Addressed

Priority:

- 9-12.PS2.A.2 Use mathematical representations to support and verify the concepts 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.]
- 9-12.PS2.A.3 Apply scientific principles of motion and momentum 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.]

Supporting:

- AP Physics 1-3.A.1. The student is able to express the motion of an object using narrative, mathematical, and graphical representations.
- ISTE - KNOWLEDGE COLLECTOR.3: Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.
- ISTE - CREATIVE COMMUNICATOR.6: Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.
- ISTE-DIGITAL CITIZEN.2: Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.

Detailed Description/Instructions: Students will investigate and explain collisions that could occur in their everyday life. This could include investigation of an actual product/safety device, analysis of high-speed video, dropping objects onto concrete, smashing items with bowling balls, egg drop challenge, etc.

Bloom's Levels: Apply

Webb's DOK: 3

Topic 3: Science/Consumer Skills

Engaging Experience 1

Title: Evaluating Claims

Suggested Length of Time: 1-2 blocks

Standards Addressed

Priority:

- 9-12.PS2.A.2 Use mathematical representations to support and verify the concepts 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.]
- 9-12.PS2.A.3 Apply scientific principles of motion and momentum 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.]
- 9-12.PS3.A.1 Create a computational model to calculate the change in the energy of one component in a system when the changes in energy are known. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.]
- 9-12.PS3.A.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 constraints could include use of renewable energy forms and efficiency.]
- 9-12.PS3.B.1 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 at different temperatures to water.]

Supporting:

- 9-12.ETS1.A.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.
- 9-12.ETS1.B.2 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 System relevant to the problem.
- AP Physics 1-3.A.1. The student is able to express the motion of an object using narrative, mathematical, and graphical representations.
- ISTE-DIGITAL CITIZEN.2: Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.
- ISTE - KNOWLEDGE COLLECTOR.3: Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.

Detailed Description/Instructions: Students should read, listen, or watch various pieces of information that appear to be based in science and then evaluate the validity of that information. This could include but is not limited to fake YouTube videos, investment schemes, information presented to congress, news stories, and product packaging. The evaluation could include group discussion, experiments, reverse engineering, etc.

Bloom's Levels: Evaluate

Webb's DOK: 3

Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.)

Students will perform a lab that includes conservation of linear momentum and conservation of energy (likely mechanical energy). Possibilities include but are not limited to the ballistic pendulum lab, a lab with nerf guns and toy cars, a lab with springs and collisions, etc.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Conservation of Energy	Mechanical Energy and Work	Apply the ideas of ME and W to a computer simulation like line rider. Other possibilities could include PHET simulations or other games.	1 Block
Conservation of Momentum	Applying Conservation of Momentum and the Impulse Momentum Theorem to everyday life	Students will investigate and explain collisions that could occur in their everyday life. This could include investigation of an actual product/safety device, analysis of high-speed video, dropping objects onto concrete, smashing items with bowling balls, egg drop challenge, etc.	2-4 Blocks
Science/ Consumer Skills	Evaluating Claims	Students should read, listen, or watch various pieces of information that appear to be based in science and then evaluate the validity of that information. This could include but is not limited to fake YouTube videos, investment schemes, information presented to congress, news stories, and product packaging. The evaluation could include group discussion, experiments, reverse engineering, etc.	1-2 Blocks

Unit 3: Waves

Subject: Physics

Grade: 10-12

Name of Unit: Waves

Length of Unit: 4 Weeks

Overview of Unit: Students explore the ways that energy moves through and interacts with its surroundings.

Priority Standards for unit:

- 9-12.PS4.B.1 Communicate technical information about how electromagnetic radiation interacts with matter. [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.]
- 9-12.PS4.A.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 traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.]

Supporting Standards for unit:

- 9-12.ETS1.A.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.
- 9-12.ETS1.B.2 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 System relevant to the problem.
- AP Physics 1-3.A.1. The student is able to express the motion of an object using narrative, mathematical, and graphical representations.
- ISTE-DIGITAL CITIZEN.2: Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.
- ISTE - KNOWLEDGE COLLECTOR.3: Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.
- ISTE - COMPUTATIONAL THINKER.5: Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.
- ISTE - CREATIVE COMMUNICATOR.6: Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.

- TT.AB.J.12: Students will recognize unfairness on the individual level (e.g., biased speech) and injustice at the institutional or systemic level (e.g., discrimination).
- TT.AB.J.13: Students will analyze the harmful impact of bias and injustice on the world, historically and today.

Unwrapped Concepts (Students need to know)	Unwrapped Skills (Students need to be able to do)	Bloom's Taxonomy Levels	Webb's DOK
Technical information about how waves interacts with matter	Analyze	Analyze	3
Mathematical representations to support a claim regarding relationships among frequency, wavelength, and speed of waves traveling in various media	Use	Apply	3

Essential Questions:

1. How do we use the properties of a wave to determine its speed?
2. How do waves interact with their surroundings?

Enduring Understanding/Big Ideas:

1. Students are able to experimentally find the speed of wave using various methods and the relationship between speed, wavelength, and frequency.
2. Students are able to analyze and describe many interactions involving waves including but not limited to, refraction, reflection, interference, Doppler effect.

Unit Vocabulary:

Academic Cross-Curricular Words	Content/Domain Specific
Frequency Wavelength Pitch Amplitude Period Crest/Peak Trough Propagate/Propagation Parallel Phase	Constructive/Destructive Interference Focal Length Reflection Refraction Diffraction Medium Resonance Standing wave Harmonic Fundamental Node Antinode

	Vacuum Mechanical wave Longitudinal/compressional Transverse Electromagnetic Pulse Compression Rarefaction Phase Decibels Intensity Dampening
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Topic 1: Properties of Waves and Interactions

Engaging Experience 1

Title: Doppler effect

Suggested Length of Time: 1/2 Block

Standards Addressed

Priority:

- 9-12.PS4.B.1 Communicate technical information about how electromagnetic radiation interacts with matter.

Supporting:

- 9-12.ETS1.A.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.
- 9-12.ETS1.B.2 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 System relevant to the problem

Detailed Description/Instructions: This would be a combination of small group and whole class activities and demos to qualitatively demonstrate the Doppler effect in action. Example include, but are not limited to; Throwing a Doppler ball around the room, having a student run down the hall with a Bluetooth speaker, videos that show simulations of how the wave fronts are compressed on in front of the object that is producing the sound and spread out behind the object that is making the sound. The big idea is to show students that the actual speed of sound is not changing, the fact that the object making the sound is moving causes our perception of the pitch of the sound to change.

Bloom's Levels: Analyze

Webb's DOK: 3

Engaging Experience 2

Title: Demos of wave properties

Suggested Length of Time: 1/2 Block

Standards Addressed

Priority:

- 9-12.PS4.B.1 Communicate technical information about how electromagnetic radiation interacts with matter.

Supporting:

- AP Physics 1-3.A.1. The student is able to express the motion of an object using narrative, mathematical, and graphical representations.

Detailed Description/Instructions: Some sort of apparatus (Slinky, Snakey, Gummy bear wave machine, etc.) can be used to simulate some basic properties of a wave such as; reflections, interference, longitudinal vs transverse waves, particles in a medium do not travel with the wave, amplitude does not affect the speed of a wave, standing waves, nodes/antinodes. This is another case where depending on materials it could be done in small groups as an investigation or as a whole class with a demo.

Bloom's Levels: Understand

Webb's DOK: 2

Topic 2: $V=\lambda f$

Engaging Experience 1

Title: Determine the relationship between speed, frequency, and wavelength of a wave

Suggested Length of Time: 1 Block

Standards Addressed

Priority:

- 9-12.PS4.A.1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

Supporting:

- AP Physics 1-3.A.1. The student is able to express the motion of an object using narrative, mathematical, and graphical representations
- ISTE - COMPUTATIONAL THINKER.5: Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.

Detailed Description/Instructions: Depending on materials available this could be done physically using materials such as a slinky or a snakey, or it could be done using a computer simulation (such as Phet). The idea is that students are given a question (could be split into 2), “what is the relationship between the speed of a wave, frequency of a wave, and wavelength of a wave?”. Students will then need to qualitatively determine what the relationship between each of the variables is (i.e. if frequency is kept constant and wavelength is increased what happens to the speed of the wave). This could be guided by the teacher or left open for students to see what they can find and then present their findings to the whole class. The goal is to qualitatively determine the mathematical relationship between the 3 variables in terms of directly related or inversely related.

Bloom’s Levels: Analyze

Webb’s DOK: 3

Engaging Experience 2

Title: Calculate the speed of light

Suggested Length of Time: 1 Block

Standards Addressed

Priority:

- 9-12.PS4.A.1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media

Supporting:

- AP Physics 1-3.A.1. The student is able to express the motion of an object using narrative, mathematical, and graphical representations.

Detailed Description/Instructions: One way this could be done is to have students devise a procedure that will allow them (or the whole class) to measure the speed of light using a microwave. Microwaves produce standing waves of light. If you can measure 2 antinodes of that light wave you can obtain the wavelength of the light wave and use the frequency on the back of the microwave to calculate the speed of light. Typically, background information has been given on how a microwave works and students have already dealt with the concepts of standing waves.

Bloom's Levels: Apply

Webb's DOK: 3

Engaging Scenario

Engaging Scenario (An Engaging Scenario is a culminating activity that includes the following components: situation, challenge, specific roles, audience, product or performance.)

1) Speed of sound: After learning about properties of waves and standing waves, students will use objects such as resonance tubes to measure the value for the speed of sound in the room. It is suggested that, other than explaining how the materials work that, this be done as an open-ended lab where the students have to devise a procedure to use the tubes to find the speed of sound.

2) Waves project: This is an opportunity for students to use technology to research and present about a real-world application of the ideas behind waves. Students are given a list of topics to pick from that are all real-world phenomena or technology that uses concepts of waves to function in the way that they do. With a partner, they need to research their topic and state what the topic is, how the topic works, and how it is related to waves. They then need to produce a presentation using some multimedia device, other than your typical PowerPoint slides or Prezi, to present their findings to the class.

3) Focal length of a mirror/lens: Students will use concepts of the properties of waves to determine the focal length of a mirror or a lens. This is an activity that could be open-ended or guided.

Culminating Video Project:

Students create a video on a topic of their choosing. The topic must be something beyond what was done in class or something not touched on at all. Style of presentation is up to the student. Groups could build something and explain how it works, collect real world data about an interest, explain ideas beyond the course content, etc. The main goal is for them to teach the class something while keeping everyone's interest.

Summary of Engaging Learning Experiences for Topics

Topic	Engaging Experience Title	Description	Suggested Length of Time
Properties of Waves and Interactions	Doppler effect	This would be a combination of small group and whole class activities and demos to qualitatively demonstrate the Doppler effect in action. Example include, but are not limited to; Throwing a Doppler ball around the room, having a student run down the hall with a Bluetooth speaker, videos that show simulations of how the wave fronts are compressed on in front of the object that is producing the sound and spread out behind the object that is making the sound. The big idea is to show students that the actual speed of sound is not changing, the fact that the object making the sound is moving causes our perception of the pitch of the sound to change.	½ Block
Properties of Waves and Interactions	Demos of wave properties	Some sort of apparatus (Slinky, Snakey, Gummy bear wave machine, etc.) can be used to simulate some basic properties of a wave such as; reflections, interference, longitudinal vs transverse waves, particles in a medium do not travel with the wave, amplitude does not affect the speed of a wave, standing waves, nodes/antinodes. This is another case where depending on materials it could be done in small groups as an investigation or as a whole class with a demo.	½ Block
$V=F\lambda$	Determine the relationship between speed, frequency, and wavelength of a wave	Depending on materials available this could be done physically using materials such as a slinky or a snakey, or it could be done using a computer simulation (such as Phet). The idea is that students are given a question (could be split into 2), “what is the relationship between the speed of a wave, frequency of a wave, and wavelength of a wave?”. Students will then need to qualitatively determine	1 Block

		<p>what the relationship between each of the variables is (i.e. if frequency is kept constant and wavelength is increased what happens to the speed of the wave). This could be guided by the teacher or left open for students to see what they can find and then present their findings to the whole class.</p> <p>The goal is to qualitatively determine the mathematical relationship between the 3 variables in terms of directly related or inversely related.</p>	
$V=F\lambda$	Calculate the speed of light	<p>One way this could be done is to have students devise a procedure that will allow them (or the whole class) to measure the speed of light using a microwave. Microwaves produce standing waves of light. If you can measure 2 antinodes of that light wave you can obtain the wavelength of the light wave and use the frequency on the back of the microwave to calculate the speed of light.</p> <p>Typically, background information has been given on how a microwave works and students have already dealt with the concepts of standing waves.</p>	1 Block

Unit of Study Terminology

Appendices: All Appendices and supporting material can be found in this course's shell course in the District's Learning Management System.

Assessment Leveling Guide: A tool to use when writing assessments in order to maintain the appropriate level of rigor that matches the standard.

Big Ideas/Enduring Understandings: Foundational understandings teachers want students to be able to discover and state in their own words by the end of the unit of study. These are answers to the essential questions.

Engaging Experience: Each topic is broken into a list of engaging experiences for students. These experiences are aligned to priority and supporting standards, thus stating what students should be able to do. An example of an engaging experience is provided in the description, but a teacher has the autonomy to substitute one of their own that aligns to the level of rigor stated in the standards.

Engaging Scenario: This is a culminating activity in which students are given a role, situation, challenge, audience, and a product or performance is specified. Each unit contains an example of an engaging scenario, but a teacher has the ability to substitute with the same intent in mind.

Essential Questions: Engaging, open-ended questions that teachers can use to engage students in the learning.

Priority Standards: What every student should know and be able to do. These were chosen because of their necessity for success in the next course, the state assessment, and life.

Supporting Standards: Additional standards that support the learning within the unit.

Topic: These are the main teaching points for the unit. Units can have anywhere from one topic to many, depending on the depth of the unit.

Unit of Study: Series of learning experiences/related assessments based on designated priority standards and related supporting standards.

Unit Vocabulary: Words students will encounter within the unit that are essential to understanding. Academic Cross-Curricular words (also called Tier 2 words) are those that can be found in multiple content areas, not just this one. Content/Domain Specific vocabulary words are those found specifically within the content.