CP- Freshman Physics Curriculum Map 2020

Updated 8/12/2020

	Pacing Guide	
Unit	**Topics**	**Time Frame**
Describing Motion (Kinematics)	❑ Introducing Technology ❑ Describing Motion with Words ❑ Describing Motion with Diagrams ❑ Position vs. Time Graphs ❑ Velocity vs. Time Graphs ❑ Free-Fall and Acceleration due to Gravity ❑ Describing Motion with Equations ❑ First Equation Only	10 weeks
Newton's Laws	❑ Newton's First Law ❑ Force and its Representation ❑ Newton's Second Law ❑ Newton's Third Law ❑	10 weeks
Work and Energy	❑ Basic Terminology and Concepts	6 weeks
Momentum	❑ The Impulse-Momentum Change Theorem ❑ Momentum Equation	5 weeks
Waves	❑ Vibrations ❑ The Nature of a Wave ❑ Properties of a Wave	6 weeks

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updated 8/15/2020

Unit 1 Summary: Describing Motion

Kinematics is a branch of physics that describes ***how*** objects move. How something moves can be expressed as words, measurements, diagrams, equations, and/or graphs. These descriptions can be scalar (size only) or vector (size and direction) in nature. In this unit, students will learn the major kinematics terms (distance, displacement, speed, velocity, and acceleration) and how they are used to describe the motion of an object. This unit will emphasize the importance of using motion diagrams, graphical analysis, and equations to describe and predict the motion of an object. Students will use a combination of student inquiry, data collection to simulation work strengthen their conceptual understanding of these terms as they pertain to motion.

This unit will be broken into six major topics with varying numbers of subtopics. Each lesson will be supplemented with various activities and labs that will be selected by the individual instructor. The number of days for each lesson is indicated in parentheses.

1. Vectors/ Velocity/ Acceleration Presentation
2. Describing Motion with Diagrams
3. Describing Motion with Position-Time Graphs
4. Describing Motion with Velocity-Time Graphs
5. Free Fall and Acceleration Due to Gravity
6. First Kinematics Equation

Essential Questions:

How do scalar measurements differ from vector measurements?
Which aspects of an object's motion can be described using a motion diagram?
Which aspects of an object's motion can be described using a position-time graph?
Which aspects of an object's motion can be described using a velocity-time graph?

Evidence of Learning:

Summative/Performance Assessments (Tests/Projects = 40%)

- Kinematics: Terms and Diagrams
- Kinematics: Graphical Analysis
- Kinematics: Freefall and Mathematical Analysis

Quizzes (20%)
Labs (30%)

Lab work will involve data collection using traditional data collection methods, sensor collection, video analysis, and/or simulation based material. While many sample labs will be listed here, only those denoted with a ⋆ will be required.

- Studying Motion with Toy Cars Lab
- Bowling Ball Lab⋆
- Pivet Video Lab
- Exploring Motion Lab (Vernier Software)⋆

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Practice (Homework/Classwork = 10%)
Classwork will involve questioning techniques utilizing a variety of strategies. Student learning will be monitored using responder systems, whiteboard responses, and student polling. The usage of Concept Builders will be used for students and instructors to gauge student performance on conceptual tasks. *For this level of student, it is recommended that only the "First Trophy" of material be assigned on most Concept Builders. Other materials that can be used include, but are not limited to:

- Gizmos
- Pivot Interactives
- Desmos Graphing Activities
- Physics Interactives

Formative Assessments:
Student progress will be assessed on a daily basis through ***Objective Checkpoint*** questions embedded in the lesson presentations. Concept Builders will be used at the conclusion of lessons (as homework or classwork) to check for individual student mastery*. Small quizzes should be administered after every lesson or couple of lessons.

Resources

Content and structure of this course is based on the material as presented by The Physics Classroom.

Science Recommended Accommodations & Modifications for Curriculum Implementation

Accommodations and Modifications Document

STANDARDS for Learning Targets			
NGSS	**Literacy**	**Cross curricular**	**CTE(NJSLS 9) Technology(NJSLS8)**
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	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.	Mathematics - MP.2: Reason abstractly and quantitatively.	CTE- 9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.
	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.	MP.4: Model with mathematics.	9.3.ST-ET.2 Display and communicate STEM information
	WHST.11-12.9: Draw evidence from informational	HSN.Q.A.1: Use units as a way to	Technology-

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	texts to support analysis, reflection, and research.	understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.	8.1.12.A.4 Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
		HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.	8.1.12.A.5 Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.
		HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	
		HSA.SSE.A.1: Interpret expressions that represent a quantity in terms of its context.	
		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.	
		HSA.CED.A.1: Create equations and inequalities in one variable and use them to solve problems.	
		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.	
		HSA.CED.A.4: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.	
		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.	

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Sample Measurable Objectives for Lesson Planning
Determine whether a mathematically described quantity is scalar or vector
Determine the difference between distance traveled and displacement of an object
Determine the average velocity of a moving object for a given time interval
Determine whether an object is accelerating
Determine the size and direction of an object's acceleration from motion data
Construct a diagram to accurately depict motion
Use a motion diagram to describe how an object is moving (direction, type, and relative size)
Use a vector diagram to determine the direction of an object's acceleration
Determine the direction of an object's motion from a position-time graph
Determine whether an object is at rest, constant velocity, or accelerating from a position-time graph
Calculate the velocity of a moving object from a position-time graph
Determine the direction of an object's motion from a velocity-time graph
Determine whether an object is at rest, constant velocity, or accelerating from a velocity-time graph
Calculate the acceleration of a moving object from a velocity-time graph
Determine the displacement of a moving object from a velocity-time graph
Describe the characteristics of a true free-falling object
Describe the acceleration due to gravity
Describe the motion of free-falling objects using position-time and velocity-time graphs
Describe the effects of air resistance on free-falling objects
Apply the first kinematics equation to objects in free fall

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Unit 2 Summary: Newton's Laws

Newton's Laws describe ***why*** an object is moving in a particular way. In this unit, students will learn the concept of force as a push or a pull and the major types of forces. This unit will emphasize the importance of using force diagrams to predict the motion of an object and connect that motion to the representations introduced in the previous unit. Students will use a combination of student inquiry, data collection and simulation work to strengthen their conceptual understanding of these terms as they pertain to motion.

This unit will be broken into four major topics with varying numbers of subtopics. Each lesson will be supplemented with various activities and labs that will be selected by the individual instructor. The number of days for each lesson is indicated in parentheses.

1. Newton's First Law of Motion
2. Force and its Representation *Multiple Lesson Presentation*
3. Newton's Second Law of Motion
4. Newton's Third Law of Motion

Essential Questions:

How does inertia relate to an object's motion?
What is a force and how can it be represented in a diagram?
Which aspects of an object's motion are related to force?
How do Newton's laws explain the principles of force and motion?

Evidence of Learning:

Summative/Performance Assessments (Tests/Projects = 40%)

- Newton's Laws: Inertia and Force Representations
- Newton's Laws: Second and Third Law

Quizzes (20%)
Labs (30%)

Classwork will involve questioning techniques utilizing a variety of strategies. Student learning will be monitored using responder systems, whiteboard responses, and student polling. The usage of Concept Builders will be used for students and instructors to gauge student performance on conceptual tasks. *For this level of student, it is recommended that only the "First Trophy" of material be assigned on most Concept Builders. Other materials that can be used include, only those denoted with a ⭐ will be required.

- Friction Lab⭐
- Newtons Video Lab
- Basic Forces Lab
- Fan Cart Gizmo
- Free Body Diagram Poster

Practice (Homework/Classwork = 10%)

Classwork will involve questioning techniques utilizing a variety of strategies. Student learning will be monitored using responder systems, whiteboard responses, and student polling. The usage of Concept Builders will be used for students and instructors to gauge student performance on conceptual tasks.

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Students will be provided with a unit packet, which will be modified over time to help work with conceptual examples. Other materials that can be used include, but are not limited to:

- Pivot Interactives
- Gizmos
- Physics Interactives

Formative Assessments:
Student progress will be assessed on a daily basis through ***Objective Checkpoint*** questions embedded in the lesson presentations. Concept Builders will be used at the conclusion of lessons (as homework or classwork) to check for individual student mastery*. Small quizzes should be administered after every lesson or couple of lessons.

Resources

Content and structure of this course is based on the material as presented by The Physics Classroom.

Science Recommended Accommodations & Modifications for Curriculum Implementation

Accommodations and Modifications Document

STANDARDS for Learning Targets			
NGSS	**Literacy**	**Cross curricular**	**CTE(NJSLS 9) Technology(NJSLS8)**
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	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.	Mathematics - MP.2: Reason abstractly and quantitatively.	CTE- 9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.
	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.	MP.4: Model with mathematics.	9.3.ST-ET.2 Display and communicate STEM information
	WHST.11-12.9: Draw evidence from informational texts to support analysis, reflection, and research.	HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.	Technology- 8.1.12.A.4 Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.

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	HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.	8.1.12.A.5 Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.
	HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	
	HSA.SSE.A.1: Interpret expressions that represent a quantity in terms of its context.	
	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.	
	HSA.CED.A.1: Create equations and inequalities in one variable and use them to solve problems.	
	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.	
	HSA.CED.A.4: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.	
	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.	

Sample Measurable Objectives for Lesson Planning
Predict the future motion of an object when provided with or without an unbalanced force
Use the concept of inertia to predict the motion of a light object compared to a heavy object
Predict whether an object will accelerate when provided with forces that are applied to it
Determine the individual forces acting on an object from a written description of the object's motion
Construct a free-body diagram for an object from a written description of the object's motion
Use a force diagram to determine the net force acting on an object

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Use Newton's Second Law to calculate the acceleration of an object, given the object's mass and size of the net force
Calculate an object's acceleration when multiple forces are acting upon it
Calculate individual forces acting on an object when provided with the object's mass and kinematic data
Calculate the acceleration of objects that fall in the air and compare them to objects that fall freely
Calculate the acceleration and/or individual forces acting on an object when multiple objects interact with each other
Describe Newton's Third Law of Motion
Identify action-reaction force pairs

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Unit 3 Summary: Work and Energy

In this unit, students will learn the concepts of work, mechanical energy, and power. Students will learn the different types of mechanical energy and to differentiate between open and closed systems. This unit will focus on students analyzing situations and determining if work was done and how energy was transferred. Students will use a combination of student inquiry, data collection, simulation work, and video analysis to strengthen their conceptual understanding of these terms as they pertain to motion.

This unit will be broken into four major topics with varying numbers of subtopics. Each lesson will be supplemented with various activities and labs that will be selected by the individual instructor. The number of days for each lesson is indicated in parentheses.

1. Basic Terminology and Concepts

Essential Questions:

When is work done on an object?
How are work and power related?
What are the major forms of energy?
What factors influence the potential and kinetic energy of an object?
How is energy conserved when changing from one form to another?

Evidence of Learning:

Summative/Performance Assessments (Tests/Projects = 40%)

- Work and Energy

Quizzes (20%)
Labs (30%)
Lab work will involve data collection using traditional data collection methods, sensor collection, video analysis, and/or simulation based material. While many sample labs will be listed here, only those denoted with a ⋆ will be required.

- Work and Energy Video Analysis
- Conservation of Mechanical Energy
- Power Lab⋆
- Roller Coaster Gizmo
- Marble Launcher Lab

Practice (Homework/Classwork = 10%)
Classwork will involve questioning techniques utilizing a variety of strategies. Student learning will be monitored using responder systems, whiteboard responses, and student polling. The usage of Concept Builders will be used for students and instructors to gauge student performance on conceptual tasks. Students will be provided with a unit packet, which will be modified over time to help work with conceptual examples. Other materials that can be used include, but are not limited to:

- Pivot Interactives
- Physics Interactives
- Gizmos

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Formative Assessments:
Student progress will be assessed on a daily basis through ***Objective Checkpoint*** questions embedded in the lesson presentations. Concept Builders will be used at the conclusion of lessons (as homework or classwork) to check for individual student mastery. Small quizzes should be administered after every lesson or couple of lessons.

Resources

Content and structure of this course is based on the material as presented by The Physics Classroom.

Science Recommended Accommodations & Modifications for Curriculum Implementation

Accommodations and Modifications Document

STANDARDS for Learning Targets			
NGSS	**Literacy**	**Cross curricular**	**CTE(NJSLS 9) Technology(NJSLS8)**
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.	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	Mathematics- MP.2: Reason abstractly and quantitatively.	CTE- 9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.
HS-PS3-2: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).	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	MP.4: Model with mathematics.	9.3.ST-ET.2 Display and communicate STEM information
		HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.	Technology- 8.1.12.A.4 Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
		HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.	8.1.12.A.5 Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.
		HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	

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Sample Measurable Objectives for Lesson Planning
Describe work in terms of force and displacement
Calculate work done in given situations
Describe potential energy as energy stored due to position
Differentiate between gravitational potential energy and elastic potential energy
Calculate an object's potential energy
Describe kinetic energy as energy due to an object's motion
Calculate an object's kinetic energy
Describe power as the rate at which work is done
Determine the change in mechanical energy of a system experiencing external forces

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Unit 4 Summary: Momentum

In this unit, students will learn the concepts of impulse and momentum. Students will study interactions between objects when momentum changes and when momentum is conserved. Students will apply Newton's Laws to collisions and apply impulse and momentum concepts to real world situations.

This unit will be broken into four major topics with varying numbers of subtopics. Each lesson will be supplemented with various activities and labs that will be selected by the individual instructor. The number of days for each lesson is indicated in parentheses.

1. Momentum

Essential Questions:

What is momentum?
How can the momentum of an object be changed?
How does momentum change during collisions?

Evidence of Learning:

Summative/Performance Assessments (Tests/Projects = 40%)

- Momentum

Quizzes (20%)
Labs (30%)
Lab work will involve data collection using traditional data collection methods, sensor collection, video analysis, and/or simulation based material. While many sample labs will be listed here, only those denoted with a ⋆ will be required.

- Marble Momentum Lab⋆
- Conservation of Momentum
- FanKart Physics Gizmo

Practice (Homework/Classwork = 10%)
Classwork will involve questioning techniques utilizing a variety of strategies. Student learning will be monitored using responder systems, whiteboard responses, and student polling. The usage of Concept Builders will be used for students and instructors to gauge student performance on conceptual tasks. Students will be provided with a unit packet, which will be modified over time to help work with conceptual examples. Other materials that can be used include, but are not limited to:

- Pivot Interactives
- Gizmos
- Physics Interactives

Formative Assessments:
Student progress will be assessed on a daily basis through ***Objective Checkpoint*** questions embedded in the lesson presentations. Concept Builders will be used at the conclusion of lessons (as homework or classwork) to check for individual student mastery. Small quizzes should be administered after every lesson or couple of lessons.

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Resources

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Science Recommended Accommodations & Modifications for Curriculum Implementation

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STANDARDS for Learning Targets			
NGSS	**Literacy**	**Cross curricular**	**CTE(NJSLS 9) Technology(NJSLS8)**
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.	WHST.11-12.7: 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.	Mathematics - MP.2: Reason abstractly and quantitatively.	CTE- 9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.
		MP.4: Model with mathematics.	9.3.ST-ET.2 Display and communicate STEM information
		HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.	Technology- 8.1.12.A.4 Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
		HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.	8.1.12.A.5 Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.
		HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	
		HSA.CED.A.1: Create equations and inequalities in one variable and use them to solve problems.	
		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.	

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	HSA.CED.A.4: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

Sample Measurable Objectives for Lesson Planning
Describe momentum as how difficult it is to bring an object to rest or “mass in motion”
Calculate the momentum of an object
Describe impulse in terms of momentum change and force
Solve for missing variables using the momentum equation
Apply momentum to real world situations

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Unit 5 Summary: Waves

In this unit, students will learn the properties of oscillating objects. Students will study the behavior of pendulums, springs, and waves. In this unit students will learn major terms associated with oscillatory motion (restoring force, amplitude, wavelength, frequency, and period) and use those terms to describe the motion of oscillating objects. Students will use a combination of student inquiry, data collection, simulation work, and video analysis to strengthen their conceptual understanding of these terms as they pertain to waves.

This unit will be broken into four major topics with varying numbers of subtopics. Each lesson will be supplemented with various activities and labs that will be selected by the individual instructor. The number of days for each lesson is indicated in parentheses.

1. Waves Types & Wavelength Presentation

Essential Questions:

What are the properties of an object in vibrational motion?
How do force and energy apply to vibrational motion?
What factors affect the period of a vibrating object?
What are the defining characteristics of wave motion?
What are the properties of waves?

Evidence of Learning:

Summative/Performance Assessments (Tests/Projects = 40%)

- Waves: Wave Types
- Waves: Calculating Wavelength

Quizzes (20%)

Labs (30%)

Lab work will involve data collection using traditional data collection methods, sensor collection, video analysis, and/or simulation based material. While many sample labs will be listed here, only those denoted with a ⋆ will be required.

- Pendulum Lab
- Hooke's Law Lab

Practice (Homework/Classwork = 10%)

Classwork will involve questioning techniques utilizing a variety of strategies. Student learning will be monitored using responder systems, whiteboard responses, and student polling. The usage of Concept Builders will be used for students and instructors to gauge student performance on conceptual tasks. Students will be provided with a unit packet, which will be modified over time to help work with conceptual examples. Other materials that can be used include, but are not limited to:

- Pivot Interactives
- Gizmos

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- Physics Interactives

Formative Assessments:
Student progress will be assessed on a daily basis through ***Objective Checkpoint*** questions embedded in the lesson presentations. Concept Builders will be used at the conclusion of lessons (as homework or classwork) to check for individual student mastery. Small quizzes should be administered after every lesson or couple of lessons.

Resources

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STANDARDS for Learning Targets			
NGSS	**Literacy**	**Cross curricular**	**CTE(NJSLS 9) Technology(NJSLS8)**
HS-PS4-1.: Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.	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.	Mathematics - MP.2: Reason abstractly and quantitatively. .	CTE- 9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.
		MP.4: Model with mathematics	9.3.ST-ET.2 Display and communicate STEM information
		HSA-SSE.A.1: Interpret expressions that represent a quantity in terms of its context.	Technology- 8.1.12.A.4 Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
		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.	8.1.12.A.5 Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.
		HSA.CED.A.4: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.	

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