

## Thomaston Public Schools - Curriculum Overview and Pacing Guide

<b>Course Title: High School Physics</b>		
<b>School: Thomaston High School</b>	<b>Grade: 11/12</b>	<b>Curriculum Pacing: 36 weeks</b>
<b>Unit One: Kinematics</b>	<b>Unit Two: Dynamics</b>	
<b>Unit Pacing: 6 weeks</b>	<b>Unit Pacing: 6 weeks</b>	
<p><b>Unit Overview:</b> Kinematics is the observation and analysis of motion of objects without accounting for the reason for that motion. Students will observe and measure how objects change position (distance and displacement) at different rates (speed and velocity), including where the rate is changing (acceleration). Students will create models for this motion, primarily using graphs, and analyze those models to predict outcomes of the motion observed. This unit is integrated with Advanced Algebra, Unit 1, Functions and Linear Functions, and Unit 2, Quadratic Functions.</p>	<p><b>Unit Overview:</b> Dynamics is the study of how forces exist as interactions between objects and how these forces cause changes in motion of an object. Students will create models for this motion, using graphs and hands on demonstrations, and analyze those models to predict outcomes of the motion observed. Students will also learn to draw forces as vectors and to add these vectors to compute the net force acting on an object. Students will see how their analyses explain Newton's laws of motion. This unit is integrated with Advanced Algebra, Unit 2, Quadratic Functions.</p>	
<p><b>Compelling Question:</b></p> <p>How can I observe and understand my motion and the motion of things in the world around me?</p> <ul style="list-style-type: none"> <li>● NGSS, Science and Engineering Practices: <ul style="list-style-type: none"> <li>○ SEP - Planning and Carrying Out Investigations.</li> <li>○ SEP - Analyzing and Interpreting Data.</li> </ul> </li> <li>● 21st Century Skills: <ul style="list-style-type: none"> <li>○ T21.CC.9-12.2</li> <li>○ T21.CTPS.-12.2</li> <li>○ T21.SDR.9-12.3</li> <li>○ T21.CIM.9-12.1</li> <li>○ T21.MIT.9-12.1</li> </ul> </li> </ul>	<p><b>Compelling Questions:</b></p> <ol style="list-style-type: none"> <li>1. How can I understand the way an object changes its motion?</li> <li>2. How can I determine the different forces on an object to understand the motion I observe?</li> </ol> <ul style="list-style-type: none"> <li>● NGSS: <ul style="list-style-type: none"> <li>○ HS-PS2-1 - DCI PS2.A: Forces and Motion</li> <li>○ HS-PS2-4 - DCI PS2.B: Types of Interactions</li> <li>○ HS-ETS1-1 - ETS1.A: Defining and Delimiting Engineering Problems</li> <li>○ HS-ETS1-2 - ETS1.C: Optimizing the Design Solution</li> </ul> </li> <li>● 21st Century Skills: <ul style="list-style-type: none"> <li>○ T21.CC.9-12.2</li> <li>○ T21.CTPS6-8.3</li> </ul> </li> </ul>	

	<ul style="list-style-type: none"> <li>○ T21.MIT.6-8.3</li> <li>○ T21.CIM.9-12.1</li> <li>○ T21.MIT.9-12.1</li> </ul>
<p><b>Priority Learning Targets</b></p> <p>1. I can observe, measure, analyze and model how objects move in one dimension at a constant rate.</p> <ul style="list-style-type: none"> <li>● All of the standards under Compelling Question apply.</li> </ul> <p>2. I can observe, measure, analyze and model how objects move in one dimension at a changing rate.</p> <ul style="list-style-type: none"> <li>● All of the standards under Compelling Question apply.</li> </ul> <p>3. I can observe, measure, analyze and model how objects move in two dimensions.</p> <ul style="list-style-type: none"> <li>● All of the standards under Compelling Question apply.</li> </ul>	<p><b>Priority Learning Targets</b></p> <p>1. I can observe, measure, analyze and model how a force changes an object's motion to explain Newton's 1st and 2nd laws of motion.</p> <ul style="list-style-type: none"> <li>● NGSS: <ul style="list-style-type: none"> <li>○ HS-PS2-1 - DCI PS2.A: Forces and Motion</li> </ul> </li> <li>● 21st Century Skills: <ul style="list-style-type: none"> <li>○ T21.CC.9-12.2</li> <li>○ T21.CTPS6-8.3</li> <li>○ T21.MIT.6-8.3</li> <li>○ T21.CIM.9-12.1</li> </ul> </li> </ul> <p>2. I can observe, measure, analyze and model how two objects interact to explain Newton's 3rd law of motion.</p> <ul style="list-style-type: none"> <li>● NGSS: <ul style="list-style-type: none"> <li>○ HS-PS2-4 - DCI PS2.B: Types of Interactions</li> </ul> </li> <li>● 21st Century Skills: <ul style="list-style-type: none"> <li>○ T21.CC.9-12.2</li> <li>○ T21.CTPS6-8.3</li> <li>○ T21.MIT.6-8.3</li> <li>○ T21.CIM.9-12.1</li> </ul> </li> </ul> <p>3. I can use vectors to sum up and analyze forces on an object.</p> <ul style="list-style-type: none"> <li>● NGSS: <ul style="list-style-type: none"> <li>○ HS-ETS1-1 - ETS1.A: Defining and Delimiting Engineering Problems</li> <li>○ HS-ETS1-2 - ETS1.C: Optimizing the Design Solution</li> </ul> </li> <li>● 21st Century Skills: <ul style="list-style-type: none"> <li>○ T21.MIT.9-12.1</li> </ul> </li> </ul>
<p><b>Unit Three: Energy and Momentum</b></p>	<p><b>Unit Four: Circular and Rotational Motion</b></p>

<p><b>Unit Pacing: 6 weeks</b></p>	<p><b>Unit Pacing: 6 weeks</b></p>
<p><b>Unit Overview:</b> Energy and momentum are less tangible concepts than force, and for this reason, physics and Newton’s laws of motion are generally related to forces. However, all interactions between objects result in changes of motion that can be analyzed in terms of the objects’ momentum and energy. The changes in momentum and energy relate to the unbalanced force that results from the interaction. The total energy and momentum of any system of interactions is always conserved. Therefore, students begin this unit with a study of energy, especially mechanical energy, both kinetic and potential, and see how these relate to the kinematics they learned in Unit 1. Students see how a force by one object on another can be measured as work done, and the rate of work done is measured as power. Students then will learn how to apply Newton’s laws of motion to understand momentum and impulse as the result of an interaction involving an unbalanced force. Students will again relate this concept back to kinematics in Unit 1. Students will also account for the energy and momentum before and after an interaction to understand that both are conserved. Students will create models for this motion, using graphs and hands on demonstrations, and analyze those models to predict outcomes of the motion observed. Students will also continue to draw vectors and to add these vectors to compute the momentum before and after an interaction. This unit is integrated with Advanced Algebra, Unit 3, Polynomial Functions.</p>	<p><b>Unit Overview:</b> Circular motion is the revolution of an object about a central point, such as the orbiting of a satellite or the Moon about the Earth. Rotational motion is the spinning motion of an object, such as the Earth’s rotation each day about its axis, or the spinning of a propeller on an airplane. Students will create models for this motion, often using graphs, and analyze those models to predict outcomes of the motion observed. Students will learn that circular and rotational motion are analogous to linear motion. This unit is integrated with the Pre-Calculus unit on Trigonometric Functions, and with prior Geometry units on circles and right triangles. NOTE: This unit also serves as a spiral back to Units 1 and 2, as the rotational kinematics and dynamics match up with linear kinematics and dynamics.</p>
<p><b>Compelling Questions:</b></p> <p>1.How can I understand the energy of an object in relation to its position and motion?</p> <ul style="list-style-type: none"> <li>● NGSS: <ul style="list-style-type: none"> <li>○ HS-PS2-2 - DCI PS2.A: Forces and Motion</li> <li>○ HS-PS2-3 - DCI ETS1.A: Defining and Delimiting Engineering Problems</li> </ul> </li> </ul>	<p><b>Compelling Question:</b></p> <p>How can I compare the circular or spinning motion of an object to linear motion?</p> <ul style="list-style-type: none"> <li>● NGSS: <ul style="list-style-type: none"> <li>○ HS-PS2-1 - DCI PS2.A: Forces and Motion</li> </ul> </li> </ul>

- HS-PS2-3 - DCI ETS1.C: Optimizing the Design Solution
- HS-PS3-1 - DCI PS3.B: Conservation of Energy and Energy Transfer
- HS-PS3-2 - DCI PS3.A: Definitions of Energy
- HS-ETS1-1 - ETS1.A: Defining and Delimiting Engineering Problems

- 21st Century Skills:

- T21.CC.9-12.2
- T21.CTPS.-12.4
- T21.SDR.9-12.2
- T21.CIM.9-12.3
- T21.MIT.9-12.4

2. How can I determine an object's motion, or momentum, and its energy change during an interaction with another object?

- NGSS:

- HS-PS2-2 - DCI PS2.A: Forces and Motion
- HS-PS2-3 - DCI ETS1.A: Defining and Delimiting Engineering Problems
- HS-PS2-3 - DCI ETS1.C: Optimizing the Design Solution
- HS-PS3-1 - DCI PS3.B: Conservation of Energy and Energy Transfer

- 21st Century Skills:

- T21.CC.9-12.2
- T21.CTPS.-12.4
- T21.SDR.9-12.2
- T21.CIM.9-12.3
- T21.MIT.9-12.4

- HS-PS2-3 - DCI ETS1.A: Defining and Delimiting Engineering Problems, and DCI ETS1.C: Optimizing the Design Solution
- HS-ETS1-1 - ETS1.A: Defining and Delimiting Engineering Problems
- HS-ETS1-2 - ETS1.C: Optimizing the Design Solution

- 21st Century Skills:

- T21.CC.9-12.2
- T21.CTPS.-12.2
- T21.SDR.9-12.3
- T21.CIM.9-12.1
- T21.MIT.9-12.1

### Priority Learning Targets

1. I can apply kinematics to explain the mechanical energy of an object and any change in that energy as a result of work done on the object.

- NGSS:
  - HS-PS2-2 - DCI PS2.A: Forces and Motion
  - HS-PS2-3 - DCI ETS1.A: Defining and Delimiting Engineering Problems
  - HS-PS2-3 - DCI ETS1.C: Optimizing the Design Solution
  - HS-PS3-1 - DCI PS3.B: Conservation of Energy and Energy Transfer
  
- 21st Century Skills:
  - T21.CTPS.-12.4
  - T21.SDR.9-12.2

2. I can apply kinematics and Newton's laws of motion to understand collisions between objects and the change in their momentum.

- NGSS:
  - HS-PS2-2 - DCI PS2.A: Forces and Motion
  - HS-PS2-3 - DCI ETS1.A: Defining and Delimiting Engineering Problems
  - HS-PS2-3 - DCI ETS1.C: Optimizing the Design Solution
  - HS-PS3-1 - DCI PS3.B: Conservation of Energy and Energy Transfer
  
- 21st Century Skills:
  - T21.CC.9-12.2
  - T21.CTPS.-12.4
  - T21.CIM.9-12.3

### Priority Learning Targets

1. I can observe, measure, analyze and model how objects move in a circle.

- NGSS: All of the standards under Compelling Question apply.
- 21st Century Skills:
  - T21.CC.9-12.2
  - T21.CIM.9-12.3
  - T21.SDR.9-12.3
  - T21.MIT.9-12.4

2. I can compare torque and rotational motion to force and linear motion.

- NGSS: All of the standards under Compelling Question apply.
- 21st Century Skills:
  - T21.CTPS.-12.4
  - T21.CIM.9-12.2

3. I can compare angular momentum to linear momentum and understand how both are conserved in objects undergoing interactions.

- NGSS: All of the standards under Compelling Question apply.
- 21st Century Skills:
  - T21.CTPS.-12.4
  - T21.CIM.9-12.2

<p>3. I can demonstrate how momentum and energy are conserved in any interaction.</p> <ul style="list-style-type: none"> <li>● NGSS: <ul style="list-style-type: none"> <li>○ HS-PS2-2 - DCI PS2.A: Forces and Motion</li> <li>○ HS-PS2-3 - DCI ETS1.A: Defining and Delimiting Engineering Problems</li> <li>○ HS-PS2-3 - DCI ETS1.C: Optimizing the Design Solution</li> <li>○ HS-PS3-1 - DCI PS3.B: Conservation of Energy and Energy Transfer</li> <li>○ HS-PS3-2 - DCI PS3.A: Definitions of Energy</li> <li>○ HS-ETS1-1 - ETS1.A: Defining and Delimiting Engineering Problems</li> </ul> </li> <li>● 21st Century Skills: <ul style="list-style-type: none"> <li>○ T21.CTPS.-12.1</li> <li>○ T21.SDR.9-12.3</li> </ul> </li> </ul>	
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<b>Unit Five: Simple Harmonic Motion and Wave Motion</b>	<b>Unit Six: Field Forces</b>
<b>Unit Pacing: 6 weeks</b>	<b>Unit Pacing: 6 weeks</b>
<p><b>Unit Overview:</b> Oscillations include any type of simple harmonic motion, such as moving in a circle or going back and forth, such as a vibration. All objects oscillate in some way, as the atoms making up all matter are constantly vibrating. All oscillations can produce waves of some sort, and modeling wave motion helps us to understand many natural phenomena, such as ocean waves, earthquakes, sound, and light. Students will begin the unit by observing circular motion as a form of oscillation, connecting this unit to the previous unit, Unit 4 - Circular and Rotational Motion. Students will also understand how pendulums and springs can model various types of back and forth motion. Students will learn that simple harmonic motion provides a simple model for</p>	<p><b>Unit Overview:</b> Field forces are the fundamental forces that determine the structure of the universe and everything in it. This unit focuses on two of the four fundamental field forces, gravitational force and electromagnetic force--the other two are sub-atomic forces beyond the scope of a high school physics course, the strong and weak nuclear forces. Students will learn how gravitational force holds together the celestial objects in our Solar System, as well as throughout the universe. Students will compare Newton's and Einstein's explanation of gravity. Students will then learn how electric force holds all matter together and its relationship to magnetic force. Students will connect this unit to Unit 2 - Dynamics, as well as parts of other units. This unit</p>

understanding many oscillations. Students will then see how oscillations create various types of waves, and they will learn how to model and understand waves. By the end of the unit, students will understand how all waves we observe in the world behave in similar ways, and how they also differ from one another. This unit is integrated with the Pre-Calculus unit on Trigonometric Functions, and Unit 5, Exponential and Logarithmic Functions.

is also integrated with Advanced Algebra, Unit 6, Rational and Power Functions.

**Compelling Questions:**

1. How can I understand the way objects vibrate or oscillate, displaying simple harmonic motion?

- NGSS:
  - HS-PS4-1 thru HS-PS4-5 - DCI PS4.A: Wave Properties
  - HS-PS4-4 and HS-PS4-5 - DCI PS4.B: Electromagnetic Radiation
  - HS-PS4-5 - DCI PS4.C: Information Technologies and Instrumentation
  - HS-ETS1-1 - ETS1.A: Defining and Delimiting Engineering Problems
  - HS-ETS1-2 - ETS1.C: Optimizing the Design Solution
  - HS-ETS1-3 and HS-ETS1-4 - ETS1.B: Developing Possible Solutions

- 21st Century Skills:
  - T21.CC.9-12.2
  - T21.CTPS.-12.1
  - T21.SDR.9-12.3

2. How can I understand the way wave motion transfers energy, and how can wave motion help me understand natural phenomena in m world?

- NGSS:

**Compelling Questions:**

1. How can I understand the way some forces act at a distance through a field?

- NGSS:
  - HS-PS2-3 - DCI ETS1.A: Defining and Delimiting Engineering Problems, and DCI ETS1.C: Optimizing the Design Solution
  - HS-PS2-4 - DCI PS2.B: Types of Interactions
  - HS-PS2-5 - PS3.A: Definitions of Energy
  - HS-PS3-5 - DCI PS3.C: Relationship Between Energy and Forces
  - HS-PS4-3 thru HS-PS4-5 - DCI PS4.B: Electromagnetic Radiation
  - HS-ESS1-4 - ESS1.B: Earth and the Solar System
  - HS-ETS1-1 - ETS1.A: Defining and Delimiting Engineering Problems
  - HS-ETS1-2 - ETS1.C: Optimizing the Design Solution
  - HS-ETS1-3 - ETS1.B: Developing Possible Solutions

- 21st Century Skills:
  - T21.CC.9-12.3
  - T21.CTPS.-12.3
  - T21.CIM.9-12.3
  - T21.MIT.9-12.4

- HS-PS4-1 thru HS-PS4-5 - DCI PS4.A: Wave Properties
- HS-PS4-4 and HS-PS4-5 - DCI PS4.B: Electromagnetic Radiation
- HS-PS4-5 - DCI PS4.C: Information Technologies and Instrumentation
- HS-ETS1-1 - ETS1.A: Defining and Delimiting Engineering Problems
- HS-ETS1-2 - ETS1.C: Optimizing the Design Solution
- HS-ETS1-3 and HS-ETS1-4 - ETS1.B: Developing Possible Solutions

- 21st Century Skills:
  - T21.CC.9-12.2
  - T21.CTPS.-12.1
  - T21.SDR.9-12.3

3. How can I compare various types of waves with one another, and what can I learn from this comparison?

- NGSS:
- 21st Century Skills:

2. How can I compare the field forces of gravity, electricity, and magnetism?

- NGSS:
  - HS-PS2-4 - DCI PS2.B: Types of Interactions
  - HS-PS2-5 - PS3.A: Definitions of Energy
  - HS-PS3-5 - DCI PS3.C: Relationship Between Energy and Forces
  - HS-PS4-3 thru HS-PS4-5 - DCI PS4.B: Electromagnetic Radiation
  - HS-ESS1-4 - ESS1.B: Earth and the Solar System
- 21st Century Skills:
  - T21.CC.9-12.3
  - T21.CTPS.-12.3
  - T21.CIM.9-12.3
  - T21.MIT.9-12.4

3. How can I understand the relationship between electricity and magnetism?

- NGSS:
  - HS-PS4-3 thru HS-PS4-5 - DCI PS4.B: Electromagnetic Radiation
  - HS-ETS1-1 - ETS1.A: Defining and Delimiting Engineering Problems
  - HS-ETS1-2 - ETS1.C: Optimizing the Design Solution
  - HS-ETS1-3 - ETS1.B: Developing Possible Solutions
- 21st Century Skills:
  - T21.CC.9-12.3
  - T21.CTPS.-12.3
  - T21.CIM.9-12.3
  - T21.MIT.9-12.4



### Priority Learning Targets

1. I can observe, measure, analyze and model simple harmonic motion.
  - All of the standards under Compelling Question apply.
2. I can observe, measure, analyze and model mechanical wave motion.
  - All of the standards under Compelling Question apply.
3. I can compare electromagnetic waves to mechanical waves.
  - All of the standards under Compelling Question apply.

### Priority Learning Targets

1. I can observe, analyze, calculate and model gravitational force.
  - NGSS:
    - HS-PS2-3 - DCI ETS1.A: Defining and Delimiting Engineering Problems, and DCI ETS1.C: Optimizing the Design Solution
    - HS-PS2-4 - DCI PS2.B: Types of Interactions
    - HS-PS2-5 - PS3.A: Definitions of Energy
    - HS-PS3-5 - DCI PS3.C: Relationship Between Energy and Forces
    - HS-ESS1-4 - ESS1.B: Earth and the Solar System
    - HS-ETS1-1 - ETS1.A: Defining and Delimiting Engineering Problems
    - HS-ETS1-2 - ETS1.C: Optimizing the Design Solution
    - HS-ETS1-3 - ETS1.B: Developing Possible Solutions
  - 21st Century Skills: All skills under Compelling Questions apply.
2. I can observe, analyze and model electric force and compare it to gravitational force.
  - NGSS:
    - HS-PS2-3 - DCI ETS1.A: Defining and Delimiting Engineering Problems, and DCI ETS1.C: Optimizing the Design Solution
    - HS-PS2-4 - DCI PS2.B: Types of Interactions
    - HS-PS2-5 - PS3.A: Definitions of Energy
    - HS-PS3-5 - DCI PS3.C: Relationship Between Energy and Forces
    - HS-PS4-3 thru HS-PS4-5 - DCI PS4.B: Electromagnetic Radiation
    - HS-ESS1-4 - ESS1.B: Earth and the Solar System
    - HS-ETS1-1 - ETS1.A: Defining and Delimiting Engineering Problems

- HS-ETS1-2 - ETS1.C: Optimizing the Design Solution
- HS-ETS1-3 - ETS1.B: Developing Possible Solutions

- 21st Century Skills: All skills under Compelling Questions apply.

3. I can observe, analyze and model magnetic force and understand its relationship to electric force.

- NGSS:
  - HS-PS2-4 - DCI PS2.B: Types of Interactions
  - HS-PS2-5 - PS3.A: Definitions of Energy
  - HS-PS3-5 - DCI PS3.C: Relationship Between Energy and Forces
  - HS-PS4-3 thru HS-PS4-5 - DCI PS4.B: Electromagnetic Radiation
  - HS-ETS1-1 - ETS1.A: Defining and Delimiting Engineering Problems
  - HS-ETS1-2 - ETS1.C: Optimizing the Design Solution
  - HS-ETS1-3 - ETS1.B: Developing Possible Solutions
- 21st Century Skills: All skills under Compelling Questions apply.