Bayonne High School

Unit 4: Impulse, Momentum

Revised 2022-23

Aligned to the New Jersey Student Learning Standards 2020

Marking Period	Unit Title	Recommended Instructional Days
2	**Impulse, Momentum**	**17**

NJSLS - Science: *Title*	NJSLS - Science: *Performance Expectations*	**Recommended Activities, Investigations, Interdisciplinary Connections, and/or Student Experiences to Explore NJSLS-S within Unit**
Motion and Stability: Forces and Interactions	**HS-PS2-1:** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object sliding down a ramp, or a moving object being pulled by a constant force.] [Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.] **HS-PS2-2:** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. [Clarification Statement: Emphasis is on the quantitative conservation of	

	momentum in interactions and the qualitative meaning of this principle.] [Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.] **HS-PS2-3:** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. [Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.] [Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.]	
FOUNDATION Disciplinary: ***Core Idea***	**FOUNDATION Disciplinary:** ***Statement***	
Forces and Motion	**HS-PS2.A:** Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. **HS-PS2.A:** If a system interacts with objects outside itself, the total momentum of the system can change;	**Essential Question/s:** • How do you identify a productive system? • How do you define the momentum of a system? • How can you represent the momentum of a system visually? • How can you represent the momentum of a system mathematically? • What affects the total momentum of a system?

	however, any such change is balanced by changes in the momentum of objects outside the system.	**Activity Description**: ● **Where's the Money?:** Students are given a scenario in which they begin with a certain amount of money, and they study how that initial amount changes over time due to various deposits and purchases. They must balance the amount of money at different stages, which mimics the law of momentum conservation. ● **Collision and Explosion of Carts on a Low Friction Track:** Students investigate collisions and explosions between carts of different masses using motion sensors to find that in the absence of an external force during the collision or explosion, the total momentum of the two cart and mass system stays constant. Students perform elastic and inelastic collisions and find that the system's momentum is constant in both cases. ● **Bumper Design Investigation:** Students design a paper bumper that will soften the impact of the collision between a cart and a fixed block of wood. Students evaluate their designs by the shape of an acceleration-versus-time graph of the collision ● **Impulse and Change in Momentum Investigation:** Students working in small groups, use a motion detector and a force sensor to measure the change in momentum of a dynamics cart and compare it to the impulse by an external object. Students account for assumptions and uncertainties in measurements and how the uncertainties affect the reliability of the results. **Interdisciplinary Connections: Content: NJSLS:** *Connections to NJSLS – English Language Arts*
FOUNDATION **Science and Engineering Practices:** ***Core Idea***	**FOUNDATION** **Science and Engineering Practices:** ***Statement***	
Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. **Analyzing and Interpreting Data:** Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. **Using Mathematics and Computational Thinking:** Mathematical and computational thinking at the 9–12 builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions	● Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. ● Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. ● Use mathematical representations of phenomena to describe explanations. ● Apply scientific ideas to solve a design problem, taking into	

including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. **Construction Explanations and Designing Solutions:** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. **Engaging in Argument from Evidence:** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	account possible unanticipated effects. ● Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence.	● **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. ● **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. ● **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. *Connections to NJSLS – Mathematics* ● **MP.2:** Reason abstractly and quantitatively. ● **MP.4:** Model with mathematics. ● **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. ● **HSN-Q.A.2:** Define appropriate quantities for the purpose of descriptive modeling.
FOUNDATION **Crosscutting Concepts:** ***Core Idea***	**FOUNDATION** **Crosscutting Concepts:** ***Statement***	

● **Patterns** ● **Cause and Effect** ● **Systems and System Models**	● Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. ● When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.	
Social and Emotional Learning: ***Competencies***	**Social and Emotional Learning:** ***Sub-Competencies***	
● Self-Awareness ● Social Awareness ● Relationship Skills	● Recognizing Strengths ● Respect for Others ● Communication ● Social Engagement ● Teamwork	

Assessments (Formative) ***To show evidence of meeting the standard/s, students will successfully engage within:***	**Assessments (Summative)** ***To show evidence of meeting the standard/s, students will successfully complete:***
Formative Assessments: ● Warm-up quizzes, student responses through group work and class discussion	**Benchmarks:** ● District Assessment **Summative Assessments:** ● Momentum Test ● Written report based on the Bumper Design Investigation
Differentiated Student Access to Content:	

Teaching and Learning *Resources/Materials*			
Core Resources	**Alternate Core Resources *IEP/504/At-Risk/ESL***	**ELL Core Resources**	**Gifted & Talented Core Resources**
● Student Chromebooks ● Lab equipment such as Vernier carts and track, etc. ● Course textbook	● Scaffolded Notes ● Leveled physics games and simulations	● Scaffolded Notes ● Google Translate	● Extension Activities ● Leveled physics games and simulations
Supplemental Resources			
Technology: ● Schoology ● Investigative Science Learning Environment Physics Videos ● PhET Physics Simulations ● Physics-related and school-appropriate YouTube videos ● Universe and More Physics Games			
Differentiated Student Access to Content: Recommended *Strategies & Techniques*			
Core Resources	**Alternate Core Resources *IEP/504/At-Risk/ESL***	**ELL Core Resources**	**Gifted & Talented Core**
● Promote an approach that benefits multiple learning styles exploring phenomena through readings, videos, and collaborative work. ● Establishing proper safety protocols for using specialized equipment and gathering materials. ● Establishing communication protocols for collaborative activities to ensure all	● Utilize a multi-sensory approach during instruction, provide multiple presentations of skills by varying the method (repetition, simple verbal explanations, mathematical representations, visual representations, etc.), modify test content and/or format, allow students to retake test for	● Utilize a multi-sensory approach during instruction, provide multiple presentations of skills by varying the method (repetition, simple verbal explanations, mathematical representations, visual representations, etc.), modify test content and/or format, allow students to retake test for additional credit, provide additional times and	● Create an enhanced set of introductory activities, integrate active teaching/learning opportunities, incorporate authentic components, propose interest-based extension activities, and connect students to related talent development opportunities.

students properly communicate and involve every student. ● Demonstrate that the Engineering Design Process is a flexible cycle that allows for steps to be repeated.	additional credit, provide additional times and preferential seating as needed, review, restate and repeat directions, provide study guides, and/or break assignments into segments of shorter tasks.	preferential seating as needed, review, restate and repeat directions, provide study guides, and/or break assignments into segments of shorter tasks.	

NJSLS CAREER READINESS, LIFE LITERACIES & KEY SKILLS	**Disciplinary Concept:** Technology Literacy	
	Core Ideas:	Digital tools differ in features, capacities, and styles. Knowledge of different digital tools is helpful in selecting the best tool for a given task.
	Performance Expectation/s:	9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
	Career Readiness, Life Literacies, & Key Skills Practices	
	Practice: Utilize critical thinking to make sense of problems and persevere in solving them.	***Description:*** Students readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

New Jersey Legislative Statutes and Administrative Code
(place an "X" before each law/statute if/when present within the curriculum map)

	Amistad Law: *N.J.S.A. 18A 52:16A-88*		Holocaust Law: *N.J.S.A. 18A:35-28*		LGBT and Disabilities Law: *N.J.S.A. 18A:35-4.35*		Diversity & Inclusion: *N.J.S.A. 18A:35-4.36a*		Standards in Action: *Climate Change*