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Bayonne High School

Unit 2: Forces in One Dimension

Revised 2022-23

Aligned to the New Jersey Student Learning Standards 2020

Marking Period	**Unit Title**	**Recommended Instructional Days**
1	**Forces in One Dimension**	**19**

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.]	
FOUNDATION Disciplinary: *Core Idea*	**FOUNDATION Disciplinary: *Statement***	
Forces and Motion	**HS-PS2.A:** Newton's second law accurately predicts changes in the motion of macroscopic objects.	**Essential Question/s:** • Why do objects move the way they do?

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 including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational	● 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 account possible unanticipated effects. ● Make and defend a claim based on evidence about the natural world or	● How can you represent interactions between different objects visually? ● How can you represent interactions between different objects mathematically? **<u>Activity Description</u>:** ● **Vector Addition:** Students work in pairs to come up with different types of scalar and vector quantities while explaining the difference. Following this, students will displace an object at different positions and find the resultant displacement vector both qualitatively and quantitatively. Students use the vector addition simulation at PhET simulations to see how the tip to tail method and the component method of vector addition work. https://phet.colorado.edu/en/simulation/legacy/vector-addition ● **Construction Paper Activity to Introduce Trig Functions:** Using a triangular piece of construction paper, students measure the sides and the angles, calculate the ratios of sides and record. Then cut the triangle parallel to one of the sides, using a straightedge and scissors, measure all quantities again and repeat. Cut a different side of the triangle, along a straight line parallel to the side and repeat the steps above. Students notice that there is a pattern in the ratios of sides of the right triangle, the ratios remain constant even when we keep cutting the triangle. We call the ratios “Trig functions”. ● **Broom-Ball Activity:** Students use a broom to make a bowling ball move along given paths in certain ways. Students realize that a constant force is not needed to keep an object moving at constant speed in a nearly frictionless situation. Students develop a qualitative relationship between total force and the acceleration of an object. ● **Newton’s Third Law Activity:** Students hook up two spring scales, only one student pulls, while the other doesn’t do anything. They will

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. **Obtaining, Evaluating, and Communicating Information:** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.	the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence. • Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	realize that the spring scales read the same value in each case. This is followed by a demo of two carts colliding with force sensors attached to the carts. The graphs of force vs. time for each cart show equal and opposite forces. • **Gravitational Field Strength Investigation:** Students hang various masses from a spring scale, keeping track of the mass and the gravitational force. Students will graph gravitational force vs. mass using a graphical analysis software and find how the two quantities are related. Gravitational field strength, ‘g’, is the slope of this graph. Students think about what this graph would look like on a planet of different mass or radius. • **Coefficient of Friction:** Students work in groups to discover that the coefficient of friction (μ) between two objects is independent of the surface area in contact between the two objects. Students are given friction blocks, different types of surfaces and spring scales, and are asked to collect data and solve for the coefficient of friction for each block - surface interaction. Students see the difference between static and kinetic coefficient of friction. Students explain their findings using word descriptions and free-body diagrams of the block being dragged. Students compare the coefficient of friction between pairs of various surfaces from real life situations. • **Newton’s Second Law Activity:** Students use a cart on a low friction track, rubber bands and known masses that go on the cart. Students pull the carts back to certain distances using a robber band and measure the velocity of the cart when it is just released by the rubber band using a photogate. Students graph the relationship between acceleration of the cart and mass system and the mass of the cart and mass system. Students investigate the relationship between total force on a system and the acceleration of the system by releasing the same cart using an increasing number of rubber bands. Combining the two relationships leads to Newton's Second Law of Motion.
FOUNDATION	**FOUNDATION**	

Crosscutting Concepts: ***Core Idea***	**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

- **PhET Simulation, Forces and Motion:** Students explore how the total force affects a system's acceleration using various objects in the simulation. Students make predictions using Newton's Laws before seeing the results using the simulation, then discuss their findings with peers.

- **Terminal Velocity Investigations:** Students analyze the motion of an object with a parachute falling through the atmosphere, to find that air resistance is significant in this case. As a follow up to this activity, students use coffee filters, time their drop from a certain height to see if the coffee filters moved at constant velocity or if they had an acceleration. This leads to the idea of terminal velocity of objects that face significant air resistance. http://concord.org/stem-resources/parachute-and-terminal-velocity

- **Lives of Diverse Scientists:** Alma Stephanie Tapia - NASA Materials Engineer, Amy Alexander - Biomedical Engineer, Brennetta Harris - Architectural Drafter, Rachel Gitajn - Bicycle Engineer

https://www.tpt.org/scigirls-profiles/video/alma-stephanie-tapia-ingeniera-en-materiales-engineer-kpuijq/
https://www.tpt.org/scigirls-profiles/video/amy-alexander-biomedical-engineer-vbdbrr/
https://www.tpt.org/scigirls-profiles/video/tpt-brennetta-harris-architectural-drafter/
https://www.tpt.org/scigirls-profiles/video/tpt-rachel-gitajn-bicycle-engineer/

- **Roving on the Moon Activity:** Students design and build cardboard and rubber band rovers with highest possible acceleration over a 2 meter span. Students will apply Kinematics principles to take measurements and determine Dynamics quantities for their device. https://www.jpl.nasa.gov/edu/teach/activity/roving-on-the-moon/

		Interdisciplinary Connections: Content: NJSLS: *Connections to NJSLS – English Language Arts* ● **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. *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.

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:** ● Dynamics Test ● Written report based on the Coefficient of Friction Activity
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 spring scales, Vernier carts, tracks, 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)

x	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*