Bayonne High School

Unit 3: Two-Dimensional Motion, Universal Gravitation

Revised 2022-23

Aligned to the New Jersey Student Learning Standards 2020

Marking Period	Unit Title	Recommended Instructional Days
2	**Two-Dimensional Motion, Universal Gravitation**	**23**

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-PS2-4:** Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. [Clarification Statement: Emphasis is on both quantitative and	

	conceptual descriptions of gravitational and electric fields.] [Assessment Boundary: Assessment is limited to systems with two objects.]	
FOUNDATION Disciplinary: *Core Idea*	**FOUNDATION Disciplinary: *Statement***	
Forces and Motion, Types of Interactions	**HS-PS2.A:** Newton's second law accurately predicts changes in the motion of macroscopic objects. **HS-PS2.B:** Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects.	**Essential Question/s:** ● How do objects move near Earth's surface? ● How can you represent this motion visually and mathematically? ● What causes an object to move in a circular path? ● How do massive objects interact with each other at a distance? ● How can you represent interactions between different objects visually and mathematically? **Activity Description:** ● **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 ● **Dropped Object vs. Launched Object:** Students observe a video of two objects simultaneously dropped and shot horizontally that fall through the same height. Students discuss to explain why the objects would fall in the same amount of time. Students reason why the
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.	● 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,	

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 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.	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 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).	objects move the way they move in horizontal and vertical directions using force diagrams. ● **PhET Simulation, Projectile Motion:** Students use the simulation to observe how an object's range, height and time of fall are affected as projectiles are shot from various heights, with different initial velocities. Students discuss their findings using word descriptions, graphs, motion diagrams, kinematics equations and force diagrams. ● **Marble Launcher Activity:** Students use a marble launcher placed on a horizontal table to launch a marble onto the floor. Students measure the height of the table and the horizontal distance traveled by the projectile to determine the initial velocity of the projectile as it left the launcher. Students use the initial velocity to make predictions for the range, time or the height of a projectile and see if the outcome of an experiment matches their predictions or not. Students compare results from all groups in class and discuss the assumptions and uncertainties in measurements to justify their results. ● **Bowling Ball on a Circular Path:** Students try to move a bowling ball on a circular path using a rubber mallet. This along with similar qualitative observations such as the motion of planets around stars, a merry go round, etc. leads to the idea of a central net force that is responsible for an object's circular motion. **Career Readiness, Life Literacies & Skills Activity:** ● **Pivot Circular Motion Lab: Exploring Circular motion:** Brainstorm measurable variables used in the circular motion apparatus video and identify dependent and independent variables, keeping the control variables in mind. Students work in small groups and collect relevant data for a pair of independent-dependent variables, then graph their data to look for patterns. Teacher facilitates a discussion of the patterns and helps put the patterns together into one equation (Newton's Second law for circular motion).

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.		• **Whirly Activity:** Students use a whirly (a string passing through a plastic tube with low friction edges, robber stoppers attached to the two ends of the string, assume horizontal plane of motion for CP level) to investigate or verify relationships between the total force, radius, mass, and tangential velocity of an object in uniform circular motion. • **Solar System Simulation:** In this virtual lab, students use the "My Solar System" simulation to investigate the effects of mass and distance on the velocity of objects in orbit. Students use the Law of Universal Gravitation and Newton's Third Law to reason why the objects move this way. • **The "Apple and the Moon" video:** The video helps students follow how Newton reconciled Galileo's ideas about kinematics with Kepler's work in astronomy. After watching the video, students discuss how the physics principles paved the way for astronauts to reach the moon. • **Apollo 11 Data Analysis:** Students analyze data from the Apollo 11 lunar mission to find the gravitational field strength at different distances from a planet. **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*
FOUNDATION **Crosscutting Concepts:** ***Core Idea***	**FOUNDATION** **Crosscutting Concepts:** ***Statement***	
• **Patterns** • **Cause and Effect**	• 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.	

Social and Emotional Learning: ***Competencies***	**Social and Emotional Learning:** ***Sub-Competencies***	● **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.
● 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:** ● Projectile Motion Test ● Written report based on the Marble Launcher Activity ● Circular Motion Test ● Written report based on the Whirly 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 marble launcher, 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 students properly communicate and involve every student. ● Demonstrate that the Engineering Design Process is a flexible cycle that allows for steps to be repeated.	● 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 preferential seating as needed, review, restate and repeat directions, provide study guides, and/or break assignments into segments of shorter tasks.	● 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 preferential seating as needed, review, restate and repeat directions, provide study guides, and/or break assignments into segments of shorter tasks.	● 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.

	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.

NJSLS CAREER READINESS, LIFE LITERACIES & KEY SKILLS	***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*