Dev. Date:
Established 2016-17
Rev. 2018-19
Rev. 2020-21
Rev. 2021-22
Rev. 2022-23

Bayonne High School

Unit 5: Work and Energy

Revised 2022-23

Aligned to the New Jersey Student Learning Standards 2020

Dev. Date:
Established 2016-17
Rev. 2018-19
Rev. 2020-21
Rev. 2021-22
Rev. 2022-23

Marking Period	Unit Title	Recommended Instructional Days
3	**Work and Energy**	**23**

NJSLS - Science: ***Title***	**NJSLS - Science:** ***Performance Expectations***	**Recommended Activities, Investigations, Interdisciplinary Connections, and/or Student Experiences to Explore NJSLS-S within Unit**
Energy	**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. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.] **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 position of particles (objects). [Clarification	

	Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.] **HS-PS3-3:** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]	
FOUNDATION Disciplinary: *Core Idea*	**FOUNDATION Disciplinary: *Statement***	

Forces and Motion, Definitions of Energy, Conservation of Energy and Energy Transfer	**HS-PS2.A:** Newton's second law accurately predicts changes in the motion of macroscopic objects. **HS-PS3.A:**Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. **HS-PS3.A:** At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. **HS-PS3.B:** Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. **HS-PS3.B:** Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems **HS-PS3.B:** Mathematical expressions, which quantify how the stored energy in a system depends on	**<u>Essential Question/s:</u>** ● How do you identify a productive system? ● How do you define the energy of a system? ● How can you represent the energy of a system visually? ● How can you represent the energy of a system mathematically? ● What affects the total energy of a system? **<u>Activity Description</u>**: ● **Spring Constant Investigation:** Students use springs of at least two different spring constants, find a relationship between the restoring force and the change in length of the spring as they hang various masses from the spring. The slope of the graph is the spring constant (Hooke's Law). Students discuss their assumptions and uncertainties of measurements to see when the relationship is applicable. ● **Party Popper Activity:** Students use party poppers to determine the popper's initial elastic potential energy using its maximum height. Students discuss their choice of system, decide on initial and final states for analysis and analyze the energy transformations in the process. Students may use a cell phone camera to improve their accuracy when determining the height. ● **YouTube Video of Damien Walters Running Through a Loop the Loop:** Using energy principles, students estimate the speed at which Damien must be running initially to make it through the loop without falling at the point where he is upside down inside the loop. Students make reasonable assumptions about the situation, explain and discuss their thought process. https://www.youtube.com/watch?v=OTcdutlcEJ4 ● **Power Expended in Climbing Stairs:** Students climb stairs at different rates to compare the amount of energy transferred in the

	its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.	process in different amounts of time. Students develop the idea of the rate of change of a quantity through this comparison. ● **Q-Tip Activity:** In this two-part activity, students are first given Q-tips and straws and challenged to see who can make a "blow-dart" Q-tip travel the farthest. In the second part of this activity, students use their Q-tip blowgun to collect data and calculate the acceleration of the Q-tip in the straw and the time the Q-tip spends within the straw. Students use concepts of work, energy, and kinematics to determine quantities. ● **What is warming Earth?:** Students will examine temperature data, connecting this data to their understanding of internal energy. Revisiting chemistry content developed in previous courses and applying newly developed energy content, students will begin to develop a mechanistic explanation for the steady warming of Earth. https://earth.stanford.edu/climate-change-ed/curriculum/high/earths-energy-balance ● **The Effects of Global Warming**: Students will relate carbon dioxide levels to climate change and global warming. They will explore indicators of climate change such as changes in glacial ice and consider human contribution to global warming, particularly due to automobiles. **Interdisciplinary Connections: Content: NJSLS:** *Connections to NJSLS – English Language Arts* ● **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.
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	● 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.	

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. **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.	● Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. ● 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).	● **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. *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. ● **HSN-Q.A.3:** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
FOUNDATION **Crosscutting Concepts:** ***Core Idea***	**FOUNDATION** **Crosscutting Concepts:** ***Statement***	

• **Patterns** • **Cause and Effect** • **Systems and System Models** • **Energy and Matter**	• 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. • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.	
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)	**Assessments (Summative)**

To show evidence of meeting the standard/s, students will successfully engage within:	***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:** ● Energy Test ● Written report based on the Party Popper 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 and objects of different mass, 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
- Global Climate change: Evidence https://climate.nasa.gov/evidence/
- https://www.pbslearningmedia.org/resource/ess05.sci.ess.watcyc.lp_global2/global-climate-change-the-effects-of-global-warming/

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.

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*	x	Standards in Action: *Climate Change*