Englewood Public School District
Science
Physics
First Marking Period

Unit 1: Motion, Forces, and Newton's Laws

Overview: In this unit of study, students are expected to *plan and conduct investigations*, *analyze data and using math to support claims*, and *apply scientific ideas to solve design problems* students in order to develop an understanding of ideas related to why some objects keep moving and some objects fall to the ground. Students will also build an understanding of forces and Newton's laws. The crosscutting concepts of *patterns*, *cause and effect*, and *systems and systems models* are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate proficiency in *planning and conducting investigations*, *analyzing data and using math to support claims*, and *applying scientific ideas to solve design problems* and to use these practices to demonstrate understanding of the core ideas.

Time Frame: 40 to 45 days

Enduring Understandings:
Newton's laws accurately predict the motion of macroscopic objects:
1.An object tends to maintain its current state of motion unless acted upon by an outside force.
2. The net force on an object determines its acceleration.
3. For every action, there is an equal and opposite reaction. (Forces come in equal and opposite pairs that occur at the same time.)

Essential Questions:
How can one explain and predict interactions between objects and within systems of objects?
How can motion be represented and described?
How do they know how long the yellow light should be on before it turns red? (traffic light)

Standards	Topics and Objectives	Activities	Resources	Assessments
(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.**	**Topics** Motion Acceleration Newton's Laws Forces Twenty-First Century Themes	Students will complete hands on activities for the following topics: 1. Scientific measurements 2. Kinematics in one dimension (Pasco-motion in 1D and Motion graphs) 3. Free fall 4. Force table 5. Projectile Motion (Pasco) 6. Two Part Lab - Pasco	**Text:** Glencoe Science: Physics Principals and Problems **Materials:** For scientific measurement activities: • Metric rulers • Digital Micrometers • Digital Varner calibers • Index cards	**Formative Assessments:** • Learning/Response Log • Journals • Student prior knowledge will be evaluated after completing the *Launch Labs.*

and Skills include:

- The Four C's
- Life and Career Skills
- Information and Media literacy

Objectives

Students will:

Analyze data using tools, technologies, and/or models to support the claim that objects maintain their current state of motion unless acted on by an outside force.

Analyze data using tools, technologies, and/or models 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.

Analyze data using tools, technologies, and/or models to support the claim that for every action there is an equal and opposite reaction.

Newton's Laws

Students will complete Chapter Launch Labs (See pages 3, 31, 57, 87, 119, and 147) to introduce concepts.

Student will explore forces at work in the simulations Forces and Motion Basics, Forces in One Dimension and Forces and Motion.
(A-SSE.B.3, NJSLSA.W9, CRP4)

Students will learn about position, velocity, and acceleration graphs in the simulation The Moving Man.
(N-Q.A.1, A-CED.A.2, F-IF.C.7, S-ID.A.1, HS-PS2-1)

Students will create and race a virtual car and analyze date in the Ramp Game simulation.
(MP.2, NJSLSA.R1, CRP8)

Students will watch video demonstrations of Newton's Laws of Motion and Circus Physics.
(MP.4, N-Q.A.2, NJSLSA.R7)

Students will watch Newton's 3 Laws with a Bicycle, An Athlete Uses Physics to Shatter World Records, The Physics of the "Hardest Move" in Ballet, and Misconception about Falling Objects and participate in follow-up quizzes and online discussions.
(N-Q.A.3, CRP10, 6.1.12.C.3.a)

For kinematics in one dimension activities:

- Constant Velocity cars
- Stand-alone digital photogates
- PC adapters
- Pasco Scientific software.

For free fall activity:

- Free fall discovery kit by Pasco (smart timer, drop box, control box, trigger, and time of flight accessory.)

For force table and projectile motion activities:

- Force table
- Weights,
- Table accessories
- Pasco launcher
- PC
- Pasco time of flight accessory

For Pasco Newton's Laws

- Pasco Newton's Laws Kit

For Chapter Launch Labs (see Pages 3, 31, 57, 87, 119, 147)

- Five pennies
- Tape
- Two self-propelling toy cars
- Stopwatch
- Meter stick
- Spark timer
- Timer tape
- Constant-velocity vehicle
- Dynamics cart

Summative Assessments:

- Diagnostic Tests
- Kinesthetic Assessments
- Projects
- Student needs will be assessed after completion of online simulations.
- Students will receive a grade for completed lab reports generated in the scientific lab notebook.
- Student portfolios will be used to monitor progress.

Benchmark Assessment:
A Common Formative Assessment will be given at the close of this unit to assess students' mastery of the skills identified.

Alternative Assessments:

- Practice Presentations
- Graphic Organizers
- Visual Representation
- Students will use mathematical representations of phenomena to describe or explain how gravitational force is proportional to mass and inversely proportional to distance squared.
- Students will

Student will explore gravity, freefall, and air resistance in the simulations Parachute Model and Parachute and Terminal Velocity.
(8.2.12.C.4, CRP11)

Enrichment Activity:
Student will complete additional textbook Mini Labs.
(A-CED.A.4, A-CED.A.1, 9.3.ST.2)

Student will visualize motion in The Art of Forces and Motion Activity.
(CRP8, A-SSE.A.1)

- Masking tape
- Graph paper
- Book
- 0.5-m heavyweight cord
- Two lightweight pieces of string
- Two 5-N spring scales
- 35-cm long piece of string
- 15-cm long piece of string
- 200-g object
- Protractor
- Grid
- Ball

Websites:
- Forces and Motion Basics
- Forces in One Dimension
- Forces and Motion
- The Moving Man
- Ramp Game
- Parachute Model
- Parachute and Terminal Velocity

Videos:
- Newton's Laws of Motion
- Circus Physics
- Newton's 3 Laws with a Bicycle
- An Athlete Uses Physics to Shatter World Records
- The Physics of the "Hardest Move" in Ballet
- Misconception about Falling Objects

Enrichment Lesson Plans:
See textbook Mini Labs and The Art of Forces and Motion Activity

demonstrate how Newton's Law of Universal Gravitation provides explanations for observed scientific phenomena.
- Students will analyze data using one-dimensional motion at non-relativistic speeds 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.

Accommodations and Modifications:

Students with special needs: Support staff will be available to aid students related to IEP specifications. 504 accommodations will also be attended to by all instructional leaders. Physical expectations and modifications, alternative assessments, and scaffolding strategies will be used to support this learning. The use of Universal Design for Learning (UDL) will be considered for all students as teaching strategies are considered.

ELL/ESL students: Students will be supported according to the recommendations for "can do's" as outlined by WIDA – https://www.wida.us/standards/CAN_DOs/. This particular unit has limited language barriers due to the physical nature of the curriculum.

Students at risk of school failure: Formative and summative data will be used to monitor student success at first signs of failure student work will be reviewed to determine support. This may include parent consultation, basic skills review and differentiation strategies. With considerations to UDL, time may be a factor in overcoming developmental considerations. More time and will be made available with a certified instructor to aid students in reaching the standards.

Gifted and Talented Students: Students excelling in mastery of standards will be challenged with complex, high level challenges related to the complexity in planning and carrying out investigations and analyzing and interpreting data.

English Language Learners	**Special Education**	**At-Risk**	**Gifted and Talented**
• Provide closed captions in native language for videos • Speak and display terminology • Teacher modeling • Peer modeling • Provide ELL students with multiple literacy strategies. • Word walls • Use peer readers • Give page numbers to help the students find answers • Provide a computer for written work • Provide two sets of	• Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Utilize modifications & accommodations delineated in the student's IEP • Work with paraprofessional • Use multi-sensory teaching approaches. • Work with a partner • Provide concrete examples	• Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Using visual demonstrations, illustrations, and models • Give directions/instructions verbally and in simple written format. Oral prompts can be given. • Peer Support • Increase one on one time • Teachers may modify instructions by modeling what the student is expected to do • Instructions may be printed out	• Interest based projects • Inquiry-based instruction • Independent study • Higher order thinking skills • Adjusting the pace of lessons • Real world scenarios • Student Driven Instruction • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue.

textbooks, one for home and one for school ● Provide visual aides ● Provide additional time to complete a task ● Use graphic organizers	● Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA).	in large print and hung up for the student to see during the time of the lesson. ● Review behavior expectations and make adjustments for personal space or other behaviors as needed. ● Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. ● Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).	● Collaborate with after-school programs or clubs to extend learning opportunities.

Interdisciplinary Connections:

ELA-NJSLS/ELA:
NJSLSA.R1: Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. RST.11-12.1 (HS-PS2-1)
NJSLSA.R7: Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. RST.11-12.7 (HS-PS2-1)
NJSLSA.W9: Draw evidence from literary or informational texts to support analysis, reflection, and research. WHST.11-12.9 (HS-PS2-1)

Mathematics:
MP.2: Reason abstractly and quantitatively. (HS-PS2-1)
MP.4: Model with mathematics. (HS-PS2-1)
N-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. (HS-PS2-1)
N-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1)
N-Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1)
A-SSE.A.1: Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1)

A-SSE.B.3: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1)
A-CED.A.1: Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1)
A-CED.A.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-PS2-1)
A-CED.A.4: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1)
F-IF.C.7: Graph functions expressed symbolically and show key features of the graph, by in hand in simple cases and using technology for more complicated cases. (HS-PS2-1)
S-ID.A.1: Represent data with plots on the real number line (dot plots, histograms, and box plots). (HS-PS2-1)

Integration of 21st Century Standards NJSLS 9:
9.3.ST-ET.2: Display and communicate STEM information.
9.3.ST.2: Use technology to acquire, manipulate, analyze and report data.

Career Ready Practices:
CRP4: Communicate clearly and effectively and with reason.
CRP8: Utilize critical thinking to make sense of problems and persevere in solving them.
CRP10: Plan education and career paths aligned to personal goals.
CRP11: Use technology to enhance productivity.

Integration of Technology Standards NJSLS 8:
8.2.12.C.4: Explain and identify interdependent systems and their functions.

Social Studies:
6.1.12.C.3.a: Analyze how technological developments transformed the economy, created international markets, and affected the environment in New Jersey and the nation.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data • 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. (HS-PS2-1) **Using Mathematics and Computational**	**PS2.A: Forces and Motion** • Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) • Momentum is defined for a particular frame of reference; it is the mass times the	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1) • Systems can be designed to cause a desired

Thinking • Use mathematical representations of phenomena to describe explanations. (HS-PS2-2) **Constructing Explanations and Designing Solutions** • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HSPS2-3) • Design a solution to a complex real world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) • Evaluate a solution to a complex real world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)	velocity of the object. (HS-PS2-2) • If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2) **ETS1.A: Defining and Delimiting Engineering Problems** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS23) **ETS1.C: Optimizing the Design Solution** • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to (HS-PS2-3) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)	effect. (HS-PS2-3) **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2) --- **Connections to Engineering, Technology, and Applications of Science** **Influence of Science, Engineering, and Technology on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-3) **Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. (HS-PS2-1) • Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1)