1 Motion and Forces

Content Area: **Science**
Course(s): **Applied Physical Science**
Time Period: **September**
Length: **25 instructional days**
Status: **Published**

Unit 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 second law. Finally, they will develop an understanding that the total momentum of a system of objects is conserved when there is no net force on the system. Students are also able to apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. 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.

Enduring Understandings:

- Circular motion requires the application of a constant force toward the center of the circle.
- Mechanical energy is connected through force and displacement, while momentum is connected through force and time, thus an object continues to move at a constant speed or stays at rest.
- Acceleration is the link between force and mass.
- Applying a force perpendicular to the direction of motion causes a change of direction.
- Displacement, velocity, acceleration and time are all interrelated.
- Newton's laws are not exact, but provide very good approximations unless an object is small enough that quantum effects become important.
- The law F = ma is used to solve motion problems that involve constant forces.
- When one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction.

Essential Questions:

- How can one explain and predict interactions between objects and within systems of objects?
- How do forces affect motion?
- How does air resistance affect the motion of a falling object
- How does mass affect acceleration?

Standards/Indicators/Student Learning Objectives (SLOs):

- SWBAT measure acceleration
- SWBAT measure distance and report in proper units
- SWBAT measure velocity and report with proper units
- SWBAT plan and conduct 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
- SWBAT restate newton's laws of motion and apply them explain the world

9-12.HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
9-12.HS-ETS1-1.1	Asking Questions and Defining Problems
9-12.HS-ETS1-2.6.1	Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
9-12.HS-ETS1-1.ETS1.A.1	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.
9-12.HS-PS2-1.4.1	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.
9-12.HS-PS2-2.5	Mathematical and computational thinking at the 9–12 level 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.
9-12.HS-PS2-1.PS2.A	Forces and Motion
9-12.HS-PS2-1.PS2.A.1	Newton’s second law accurately predicts changes in the motion of macroscopic objects.
9-12.HS-PS2-2.PS2.A.1	Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object.
9-12.HS-PS2-2.PS2.A.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.

Lesson Titles:

- acceleration
- distance
- Falling Objects
- Net Force
- Newton's Laws
- velocity

Career Readiness, Life Literacies & Key Skills

WRK.K-12.P.1	Act as a responsible and contributing community members and employee.
WRK.K-12.P.3	Consider the environmental, social and economic impacts of decisions.
WRK.K-12.P.4	Demonstrate creativity and innovation.
WRK.K-12.P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
WRK.K-12.P.8	Use technology to enhance productivity increase collaboration and communicate effectively.
WRK.K-12.P.9	Work productively in teams while using cultural/global competence.

Inter-Disciplinary Connections:

LA.RH.11-12.1	Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.), to support analysis of primary and secondary sources, connecting insights gained from specific details to develop an understanding of the text as a whole.
LA.RH.11-12.2	Determine the theme, central ideas, information and/or perspective(s) presented in a primary or secondary source; provide an accurate summary of how key events, ideas and/or author's perspective(s) develop over the course of the text.
LA.RH.11-12.3	Evaluate various perspectives for actions or events; determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain.
LA.RH.11-12.4	Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).
LA.RH.11-12.6	Evaluate authors' differing perspectives on the same historical event or issue by assessing the authors' claims, reasoning, and evidence.
MA.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.
MA.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
LA.RH.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, qualitatively, as well as in words) in order to address a question or solve a problem.
LA.RH.11-12.8	Evaluate an author's claims, reasoning, and evidence by corroborating or challenging them with other sources.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
LA.RH.11-12.9	Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.
LA.RST.11-12.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.RST.11-12.2	Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
MA.N-VM.A.1	Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., $\boldsymbol{v}$, $\lvert\boldsymbol{v}\rvert$, $\lvert\lvert\boldsymbol{v}\rvert\rvert$, $\boldsymbol{v}$).
MA.N-VM.A.3	Solve problems involving velocity and other quantities that can be represented by vectors.

LA.WHST.11-12.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
LA.WHST.11-12.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
LA.WHST.11-12.6	Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.

An expression is a record of a computation with numbers, symbols that represent numbers, arithmetic operations, exponentiation, and, at more advanced levels, the operation of evaluating a function. Conventions about the use of parentheses and the order of operations assure that each expression is unambiguous. Creating an expression that describes a computation involving a general quantity requires the ability to express the computation in general terms, abstracting from specific instances.

An equation is a statement of equality between two expressions, often viewed as a question asking for which values of the variables the expressions on either side are in fact equal. These values are the solutions to the equation. An identity, in contrast, is true for all values of the variables; identities are often developed by rewriting an expression in an equivalent form.

The same solution techniques used to solve equations can be used to rearrange formulas. For example, the formula for the area of a trapezoid, ð˜^ = ((ð˜£â,+ð˜£â,,)/2)ð˜©, can be solved for ð˜© using the same deductive process.

Algebraic manipulations are governed by the properties of operations and exponents, and the conventions of algebraic notation. At times, an expression is the result of applying operations to simpler expressions. For example, p + 0.05p is the sum of the simpler expressions p and 0.05p. Viewing an expression as the result of operation on simpler expressions can sometimes clarify its underlying structure.

The solutions of an equation in one variable form a set of numbers; the solutions of an equation in two variables form a set of ordered pairs of numbers, which can be plotted in the coordinate plane. Two or more equations and/or inequalities form a system. A solution for such a system must satisfy every equation and inequality in the system.

Instructional Strategies, Learning Activities, and Levels of Blooms/DOK:

- acceleration activity
- acceleration notes
- Distance review
- Egg drop project
- Falling objects notes
- Force diagrams
- Google Maps distance
- lunar lander
- Measuring car speed lab
- Measuring Lab
- net force notes
- net force practice
- Newton's laws math

- Newton's laws notes
- terminal velocity simulator
- velocity math
- Velocity notes

Modifications

ELL Modifications:

- Focus on domain specific vocabulary and keywords
- Front load information
- Group students
- Provide ELL students with multiple literacy strategies
- Sheltered English Instruction
- Use real objects when possible

IEP & 504 Modifications:

- less none of the above, all of the above, which of the following apply, or which do not apply type questions (again it is testing for understanding of the question not the content)
- providing students with content vocabulary prior to teaching a lesson including that vocabulary (pre-teaching)
- providing study guides that don't lead the student to study too much extraneous information (less unnecessary details)/scaffolded study guides
- scaffolded notes
- teaching the main ideas/concepts (limiting not needed details)to be taught and repeating them in several different ways over several different days (goal is 7 different ways same concept for students with learning disabilities)

G&T Modifications:

- Determine where students' interests lie and capitalize on their inquisitiveness. (Is there a specific career they are interested in? How would this apply to their interest?)
- Employ differentiated curriculum to keep interest high.
- Encourage students to explore concepts in depth and encourage independent studies or investigations.
- Invite students to explore different points of view on a topic of study and compare the two.
- Provide additional rigorous challenge problems for advanced students
- Student led/directed discussions

At Risk Modifications

- guided notes
- hands-on Instruction
- modeling and showing lots of examples
- non-verbal redirection of behaviors
- outlines & graphic organizers
- scaffolded notes
- slower pacing of materials
- study guides

Benchmark Assessments

Skills-based assessment

Reading response

Writing prompt

Lab practical

Alternative Assessments

Performance tasks

Project-based assignments

Problem-based assignments

Presentations

Reflective pieces

Concept maps

Case-based scenarios

Portfolios

Formative Assessment:

- acceleration quiz
- Closure
- Distance lab
- Distance quiz
- falling objects quiz
- Net Forces lab
- Net forces quiz
- Newton's laws quiz
- Velocity lab
- Velocity quiz
- Warm-up

Summative Assessment:

- Forces and Motion project
- Forces and Motion Test
- marking period assessment
- Personalized assessment

Resources & Materials:

- Forces and Motion: Explore the forces at work when you try to push a filing cabinet. Create an applied force and see the resulting friction force and total force acting on the cabinet. Charts show the forces, position, velocity, and acceleration vs. time. View a Free Body Diagram of all the forces (including gravitational and normal forces). http://phet.colorado.edu/en/simulation/forces-and-motion
- Forces in One Dimension: Explore the forces at work when you try to push a filing cabinet. Create an applied force and see the resulting friction force and total force acting on the cabinet. Charts show the forces, position, velocity, and acceleration vs. time. View a Free Body Diagram of all the forces (including gravitational and normal forces). http://phet.colorado.edu/en/simulation/forces-1d
- https://sites.google.com/site/mantonphysicalscience/
- Lab equipment
- Notes
- Parachute and Terminal Velocity: How does an object's speed change as it falls through the atmosphere? When first learning about how objects fall, usually just one force—gravity—is considered. Such a simplification only accurately describes falling motion in a vacuum. This model of a parachute carrying a load incorporates a second force—air resistance—and allows experimentation with two variables that affect its speed: the size of the parachute and the mass of its load. This model graphs both the parachute's height above the Earth's surface and its speed after it is released. Motion continues until a constant speed is achieved, the terminal velocity. http://concord.org/stem-resources/parachute-and-terminal-velocity
- practice exercises
- study guides

Technology:

- Analyze the capabilities and limitations of current and emerging technology resources and assess their potential to address personal, social, lifelong learning, and career needs. 8.1.12.D.5
- Apply previous content knowledge by creating and piloting a digital learning game or tutorial. 8.1.12.B.2
- chromebook
- Develop an innovative solution to a real world problem or issue in collaboration with peers and experts, and present ideas for feedback through social media or in an online community. 8.1.12.C.1
- http://lab.concord.org/embeddable.html#interactives/inquiry-space/parachute.json
- http://www.thephysicsaviary.com/Physics/Programs/Labs/NewtonsLawwithGraphsLab/index.html
- https://phet.colorado.edu/en/simulation/legacy/forces-and-motion
- https://phet.colorado.edu/en/simulation/lunar-lander
- https://sites.google.com/site/mantonphysicalscience/
- Internet
- Research and evaluate the impact on society of the unethical use of digital tools and present your research to peers. 8.1.12.E.2

TECH.8.1.12.A.2	Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review.
TECH.8.1.12.A.5	Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.
TECH.8.1.12.A.CS2	Select and use applications effectively and productively.
TECH.8.1.12.B.CS1	Apply existing knowledge to generate new ideas, products, or processes.
TECH.8.1.12.B.CS2	Create original works as a means of personal or group expression.
TECH.8.1.12.C.CS1	Interact, collaborate, and publish with peers, experts, or others by employing a variety of digital environments and media.
TECH.8.1.12.C.CS2	Communicate information and ideas to multiple audiences using a variety of media and formats.
TECH.8.1.12.C.CS4	Contribute to project teams to produce original works or solve problems.
TECH.8.1.12.D.1	Demonstrate appropriate application of copyright, fair use and/or Creative Commons to an original work.
TECH.8.1.12.D.CS1	Advocate and practice safe, legal, and responsible use of information and technology.
TECH.8.1.12.D.CS2	Demonstrate personal responsibility for lifelong learning.
TECH.8.1.12.F.CS1	Identify and define authentic problems and significant questions for investigation.
TECH.8.1.12.F.CS3	Collect and analyze data to identify solutions and/or make informed decisions.