03: Multidimensional Motion

Content Area: **Science**
Course(s): **Physics**
Time Period: **December**
Length: **25 days**
Status: **Published**

Unit Overview:

The purpose of this unit is to expand the student's skills in dealing with forces and motion by examining situations where objects are moving through multiple dimensions. Students will focus on projectiles, circular motion and orbital motion in this unit.

Enduring Understandings:

- Circular motion happens when forces are perpendicular to motion
- Projectiles are the result of simultaneous horizontal and vertical motion
- Vertical circles have multiple forces acting simultaneously
- Cars on a turn are the combination of friction and circular motion
- Horizontal motion does not affect vertical motion
- Orbits are the combination of circular motion and gravity

Essential Questions:

- How can we make predictions about objects moving in a circle?
- How can we make predictions about the motion of a projectile?

Standards/Indicators/Student Learning Objectives (SLOs):

- SWBAT calculate the instantaneous velocity or average speed, and acceleration of an object moving in horizontal circular motion
- SWBAT describe and calculate the motion of an object fired at an angle that is not fired and lands at the same height.
- SWBAT describe and calculate the motion of an object fired at an angle that starts and ends on the ground
- SWBAT describe and calculate the motion of an object fired horizontally
- SWBAT determine the direction and magnitude of forces causing an object to move in vertical circular motion
- SWBAT determine the force and motion of an object moving in orbit around another object
- SWBAT determine the type of force and its magnitude responsible for moving in horizontal circular motion

- SWBAT explain that an object's motion can be broken into x and y components using trigonometry.

9-12.HS-ETS1-4.4.1	Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows— within and between systems at different scales.
9-12.HS-ETS1-2.6	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.
9-12.HS-ETS1-3.6.1	Evaluate 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-ETS1-4.ETS1.B.1	Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.
9-12.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.
9-12.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.
9-12.HS-PS1-3.1.1	students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system.
9-12.HS-PS1-1.2	Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
9-12.HS-PS2-1.2.1	students understand that empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects.
9-12.HS-PS1-4.2.1	Develop a model based on evidence to illustrate the relationships between systems or between components of a system.
9-12.HS-PS1-1.2.1	Use a model to predict the relationships between systems or between components of a system.
9-12.HS-PS3-2.2.1	Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
9-12.HS-PS2-3.2.1	Systems can be designed to cause a desired effect.
9-12.HS-PS2-5.3	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.
9-12.HS-PS2-5.3.1	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.
9-12.HS-PS3-1.4.1	Models can be used to predict the behavior of a system, but these predictions have

	limited precision and reliability due to the assumptions and approximations inherent in models.
9-12.HS-PS2-2.4.1	When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.
9-12.HS-PS1-2.6	Constructing Explanations and Designing Solutions
9-12.HS-PS2-3.6.1	Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects.
9-12.HS-PS2-6.8.1	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).
9-12.HS-PS2-1.PS2.A.1	Newton's second law accurately predicts changes in the motion of macroscopic objects.
9-12.HS-PS2-3.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-PS2-3.ETS1.C.1	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 (trade-offs) may be needed.

Lesson Titles

- Horizontal Circular Motion
- Intro to 2 dimensional motion
- Orbital Motion
- Three types of Projectile Motion
- Vertical Circular Motion

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.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.11-12.7	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.RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

LA.RST.11-12.10	By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.
LA.WHST.11-12.1.A	Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
LA.WHST.11-12.1.B	Develop claim(s) and counterclaims using sound reasoning and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
LA.WHST.11-12.1.C	Use transitions (e.g., words, phrases, clauses) to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
LA.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
LA.WHST.11-12.2.E	Provide a concluding paragraph or section that supports the argument presented.
LA.WHST.11-12.10	Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

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

- Homework: Ground to Ground Angled Projectiles. One randomly generated problem dealing with a projectile that is fired horizontally.
- Homework: Horizontally Fired Projectiles. One randomly generated problem dealing with a projectile that is fired horizontally.
- Homework: Projectile Concept Form.
- Lab Activity: Best Angle. In this activity you will be discovering how different things affect the best angle
- Lab Activity: Projectile Relationships. In this activity you will investigate the relationship between some of the key variables affecting projectile motion.
- Lab Activity: Properties of Projectile Motion. In this activity you will be discovering many of the key features of projectile motion.
- Notes on the difference between 1D and 2D motion.
- Notes on the motion of projectiles (Video of Horizontally Fired Projectiles) (Video of Projectiles that start and end on the ground)
- Ownwork: Projectile Problems 1 (Horizontal Initial Motion). A sampling of problems where the projectiles begin by moving only horizontally.
- Quiz Practice: Practice Projectile Problems.
- Visualization Aid: Trig Thing. Program that shows the percentages of horizontal and vertical for different angles.

Modifications

- Tutoring During Delsea 1

ELL Modifications:

- Repeat, reword and clarify
- Digital Translators
- Focus on domain specific vocabulary and key words
- Offer sources for specific topics in primary language (Youtube web resources)
- Use real objects when possible

IEP & 504 Modifications:

- Modeling and showing various examples
- Formula sheets and example problems to use on assessments
- Scaffolding notes
- Students will be able to use calculators and/or other math tools

G&T Modifications:

- Extra labs to do outside the classroom
- Provide links to extension videos or other media
- Increase the level of problems and challenge problems

At Risk Modifications

- Reach out to parents
- Utilize Delsea One to complete assignments, try supplemental material or to modify classroom behaviors

Formative Assessment:

- Lab Assessment: 2 dimensional motion, Horizontal and Vertical Circular Motion and Orbits
- Quiz 3.1 Trigonometry Review and 2 Dimensional Motion
- Quiz 3.2 Horizontal Circular Motion
- Quiz 3.3 Vertical Circular Motion

Summative Assessment:

- MPA 2: 2 Dimensional Motion, Circular Motion and Orbits
- Unit 3 Exam: Horizontal and Vertical Circular Motion and Orbits

Alternative Assessments:

Performance tasks
Project-based assignments
Problem-based assignments
Presentations
Reflective pieces
Concept maps
Case-based scenarios
Portfolios

Benchmark Assessments:

Skills-based assessment
Reading response
Writing prompt
Lab practical

Resources & Materials:

- Cell Phone Apps for Video Editing
- Chromebooks
- https://sites.google.com/site/delseaphysics1/Home
- Lab Pro Modules and appropriate sensors
- Meter Sticks/metric Rules
- Timing Devices

Technology:

- Chromebook
- Class Website
- Ed Puzzle
- Google Classroom
- Google Suite
- Graphical Analysis Program
- Lab Pro Modules and Sensors
- Other
- Promethean Board

TECH.8.1.12 Educational Technology: All students will use digital tools to access, manage, evaluate, and

	synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
TECH.8.1.12.A.CS2	Select and use applications effectively and productively.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.1.12.B.CS2	Create original works as a means of personal or group expression.
TECH.8.1.12.C	Communication and Collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.
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.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.E	Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.
TECH.8.1.12.E.CS2	Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
TECH.8.1.12.E.CS4	Process data and report results.
TECH.8.1.12.F.1	Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs.
TECH.8.1.12.F.CS3	Collect and analyze data to identify solutions and/or make informed decisions.
TECH.8.2.12	Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
TECH.8.2.12.A.2	Analyze a current technology and the resources used, to identify the trade-offs in terms of availability, cost, desirability and waste.
TECH.8.2.12.C	Design: The design process is a systematic approach to solving problems.
TECH.8.2.12.C.4	Explain and identify interdependent systems and their functions.
TECH.8.2.12.C.CS3	The role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.
TECH.8.2.12.E	Computational Thinking: Programming: Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.