01_Kinematics

Content Area: **Science**
Course(s):
Time Period: **Full Year**
Length: **5 weeks**
Status: **Published**

General Overview, Course Description or Course Philosophy

This course is about the nature of basic things such as motion, force, energy, matter, sound, light, electricity and the composition of atoms. Laboratory experiments, demonstrations, applications to daily life and current topics in physics provide students with an appreciation of this most basic science.

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Essential Questions:

- How can you model an object's motion?
- How can you describe motion when velocity changes?

Students will understand:

- Relationships between position, velocity, and acceleration for the motion of an object in one and two dimensions
- Motion with constant acceleration
- Relationships between words, equations, and graphs for motion in one and two dimensions
- Mathematical representations can be used to understand motion and make predictions about an object’s motion

*In this unit, the students are working towards the standard and will continue to do so in the dynamics unit.

CONTENT AREA STANDARDS

SCI.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.
SCI.HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

RELATED STANDARDS (Technology, 21st Century Life & Careers, ELA Companion Standards are Required)

HSA-CED.A.1: Create equations and inequalities in one variable and use them to solve problems.
HSA-CED.A.2: Create equations in two or more variables to represent relationships between quantities; graph equations

on coordinate axes with labels and scales.
HSA-CED.A.4: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
WHST.9-12.9: Draw evidence from informational texts to support analysis, reflection, and research.

MA.S-ID.A.1	Represent data with plots on the real number line (dot plots, histograms, and box plots).
MA.A-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
MA.K-12.2	Reason abstractly and quantitatively.
PFL.9.1.K12.P.4	Demonstrate creativity and innovation.
MA.K-12.4	Model with mathematics.
MA.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.
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.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
MA.F-IF.C.7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
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.11-12.7	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.
WRK.K-12.P.4	Demonstrate creativity and innovation.
TECH.K-12.P.4	Demonstrate creativity and innovation.

STUDENT LEARNING TARGETS

Declarative Knowledge

Students will know:

- You can use displacement and velocity to describe an object's motion.
- Acceleration is the rate of chance in an object's velocity.
- Vectors and scalars are different. For example: Distance and displacement are not interchangeable.
- The terms average velocity and instantaneous velocity mean different things.
- A position-time graph and a motion diagram are not the same
- The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time
- The average acceleration equation should only be used during time intervals of constant acceleration.
- You can use vectors to describe projectile motion

The following preconceptions and/or misconceptions will be addressed during the unit:

- Positive acceleration describes speeding up, and negative acceleration describes slowing down. [Note: avoid using the word "deceleration" and instead emphasize positive and negative acceleration.]
- At the top of its trajectory, a projectile has zero acceleration.

Procedural Knowledge

Students will be able to:

- Solve problems by identifying given variables, determining the correct equation to use, solving for the necessary information, and performing calculations.
- Use the qualitative definition of acceleration to determine if the object is accelerating and representing this information with a quantitative value.
- Interpret information from a position vs. time graph, velocity vs. time graph, and acceleration vs. time graph and be able to represent the information in both qualitative and quantitative descriptions.
- Calculate the slope on a position vs. time graph and velocity vs. time graph to determine the velocity and acceleration, respectively, for the corresponding velocity vs. time and acceleration vs. time graphs.
- Calculate the area under a line on a velocity vs. time graph and acceleration vs. time graph to determine the change in position and change in acceleration, respectively, for the corresponding position vs. time and velocity vs. time graphs.

HS-PS2-1

- Organize data that represent the net force on a macroscopic object, its mass (which is held constant), and its acceleration (e.g., via tables, graphs, charts, vector drawings).
- Students use tools, technologies, and/or models to analyze the data and identify relationships within the datasets, including:

1. A more massive object experiencing the same net force as a less massive object has a smaller acceleration, and a larger net force on a given object produces a correspondingly larger acceleration
2. The result of gravitation is a constant acceleration on macroscopic objects as evidenced by the fact that the ratio of net force to mass remains constant.

- Students use the analyzed data as evidence to describe that the relationship between the observed quantities is accurately modeled across the range of data by the formula $a = \Sigma F/m$ (e.g., double force yields double acceleration, etc.)
- Students use the data as empirical evidence to distinguish between causal and correlational relationships linking force, mass, and acceleration.
- Students express the relationship $\Sigma F=ma$ in terms of causality, namely that a net force on an object causes the object to accelerate

HS-ETS1-2

- Students restate the original complex problem into a finite set of two or more sub-problems (in writing or as a diagram or flowchart).
- For at least one of the sub-problems, students propose two or more solutions that are based on student-generated data and/or scientific information from other sources.
- Students describe how solutions to the sub-problems are interconnected to solve all or part of the larger problem.
- Students describe criteria and constraints for the selected sub-problem.

- Students describe the rationale for the sequence of how sub-problems are to be solved, and which criteria should be given highest priority if tradeoffs must be made.

EVIDENCE OF LEARNING

Formative Assessments

Strategic questioning

Class/small group discussions

Homework and classwork assignments

Conducting and analyzing labs

Summative Assessments

- Benchmarks – departmental benchmark given at the end of MP1, MP2, and MP3
- Alternative Assessments
    - Lab inquiries and investigations
    - Lab Practicals
    - Exploratory activities based on phenomenon
    - Gallery walks of student work
    - Creative Extension Projects
    - Build a model of a proposed solution
    - Let students design their own flashcards to test each other
    - Keynote presentations made by students on a topic
    - Portfolio

RESOURCES (Instructional, Supplemental, Intervention Materials)

The Physics Classroom - http://www.physicsclassroom.com/

PhET simulations - https://phet.colorado.edu/

Pivot - https://www.pivotinteractives.com/

Edpuzzle - https://edpuzzle.com/

Vernier labs - teacher lab manual available in classroom

INTERDISCIPLINARY CONNECTIONS

Calculations drive connections with mathematics courses

ACCOMMODATIONS & MODIFICATIONS FOR SUBGROUPS

See link to Accommodations & Modifications document in course folder.