02_Dynamics

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 do forces affect motion?
- How can forces be described in two dimensions?

Students will understand:

- Net forces cause changes in motion
- The same basic rules govern the motion of all bodies
- Laws govern motion on Earth and throughout the universe
- Mathematical representations can be used to understand motion and make predictions about an object's motion

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-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
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.
WHST.9-12.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

MA.N-RN.A.1	Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.
MA.K-12.2	Reason abstractly and quantitatively.
MA.A-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
MA.S-ID.A.1	Represent data with plots on the real number line (dot plots, histograms, and box plots).
MA.N-RN.A.2	Rewrite expressions involving radicals and rational exponents using the properties of exponents.
PFL.9.1.K12.P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
MA.K-12.4	Model with mathematics.
MA.N-RN.B.3	Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.
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.8	Use technology to enhance productivity increase collaboration and communicate effectively.

STUDENT LEARNING TARGETS

Declarative Knowledge
Students will know:

- Net forces cause changes in motion

- The motion of an object changes only when a net force is applied
- The magnitude of acceleration of an object depends directly on the strength of the net force, and inversely on the mass of the object. This relationship ($a = F_{net}/m$) is independent of the nature of the force
- Friction is a force that acts to slow or stop the motion of objects
- Forces in two dimensions can be described using vector addition and vector resolution.
- The equilibrant is a vector that is equal in magnitude to the resultant vector, but opposite direction.

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

- Objects must have forces acting on them to have non-zero velocities
- The larger or "stronger" object in an interaction will exert a larger force on the smaller object
- At the top of its trajectory, a projectile has zero force acting on it

Procedural Knowledge

Students will be able to:

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-PS2-6

- Students use at least two different formats (including oral, graphical, textual and mathematical) to communicate scientific and technical information, including fully describing the structure, properties, and design of the chosen material(s). Students cite the origin of the information as appropriate.

- Students identify and communicate the evidence for why molecular level structure is important in the functioning of designed materials, including how the material's properties make it suitable for use in its designed function.
- Students describe that, for all materials, electrostatic forces on the atomic and molecular scale results in contact forces (e.g., friction, normal forces, stickiness) on the macroscopic scale.

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.