Unit 03: Newton’s Laws Motion and Uniform Circular Motion

Content Area: **Science**
Course(s):
Time Period: **Marking Period 2**
Length: **5-6 Weeks**
Status: **Published**

Summary

The relationship between force, mass and acceleration is explored in depth. Students investigate Newton's Laws of Motion and apply them to everyday scenarios. Students ascertain the cause of uniform circular motion and how it relates to acceleration.

Revised July 2022

Standards

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).
PFL.9.1.2.CR.1	Recognize ways to volunteer in the classroom, school and community.
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.
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.
MA.A-CED.A.1	Create equations and inequalities in one variable and use them to solve problems.
MA.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.
MA.A-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

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.
SCI.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.
SCI.HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP11	Use technology to enhance productivity.
CRP.K-12.CRP12	Work productively in teams while using cultural global competence.
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.

Essential Questions/Enduring Understandings

Essential Questions

- How are the quantities of force, mass and acceleration related?

- What is the concept of inertia and how does it apply to the world around us?

- What conditions must be met for an object to be considered in a state of translational equilibrium?

- What are the properties of uniform circular motion?

- How is uniform circular motion produced and maintained?

Enduring Understanding

- Objects resist changes to their state of motion

- Unbalanced forces acting on an object will change its state of motion

- Forces arise between objects interaction and they come in pairs

Objectives

- Students will be skilled at drawing force diagrams
- Students will know the difference between mass and weight
- Students will know the difference between a contact force and a field force
- Students will be skilled at identifying action-reaction force pairs
- Students will be skilled at using Newton's 2nd Law to predict the acceleration of objects
- Students will be skilled at experimentally determining coefficients of friction
- Students will know the principle of Inertia as it relates to linear and circular motion
- Students will be skilled at determining the net force on an object
- Students will know the nature of centripetal acceleration
- Students will be skilled at calculating the minimum critical speed for a vertical loop
- Students will know the difference between kinetic and static friction
- Students will be skilled at producing force v acceleration and mass v acceleration graphs
- Students will know the relationship between velocity and acceleration in uniform circular motion

Learning Plan

Video: "The Mechanical Universe: Inertia"

Demos and Discussion: Air Hockey / Hover puck, Egg Dive, Travel in space

PUM Lab: Force as an interaction

PHET Simulation: Force and Motion Basics

Activity: "Drawing force diagram and summing forces"

Cooperative problem solving: Equilibrium

Lab: "The relationship between Force and Acceleration"

Socratic questioning and discussion: "Everyday Forces"

Teacher Presentation: Problem solving with Newton's 2nd Law

Newton's 3rd Law discussion and demos

Lab: Determining the coefficient of kinetic friction

Demo and Discussion: Incline planes

Lab: Motion on incline planes

PHET simulation: Motion in 2D

Circular motion discussion and demos

Video: "The Mechanical Universe: Moving in Circles"

Teacher presentation: applying Newton's Law to circular motion

Collaborative problem solving: circular motion

Lab: Maintaining Circular Motion

Teacher presentation: Roller Coaster physics

Assessment

Formative:

Do Now Questions

Exit Ticket Questions

Whole Class Discussion Participation

Small Group Discussion Participation

Individual Student Questions/Responses

Cooperative Problem Solving *(Equilibrium, Circular Motion)*

Lab Experiments *(The relationship between Force and Acceleration, Determining the coefficient of kinetic friction, Motion on incline planes, Maintaining Circular Motion)*

Quizzes

Summative:

Formal Lab Report

Unit Test

Benchmark:

Honors Physics Midterm Exam

Alternative Assessments:

Guided Formal Lab Report

Unit Study Guide

Materials

Textbook T PHYSICS: PRINCIPLES WITH APPLICATIONS 6th Edition GIANCOLI, PEARSON

Mechanical Universe Video Series

Equipment for demos

Chromebooks for PhET Simulation

Lab Equipment: ramps, ball bearings, stopwatches, slotted masses, meter sticks, bricks, ring stands, projectile launchers, iphones, 60m tape measure, spring scales, balances, pulleys, sting, friction blocks

Computer / Smart board

¼ inch graph paper

Integrated Accommodation and Modifications

FOR SPECIAL EDUCATION STUDENTS , ELL, AT RISK AND STUDENTS GIFTED STUDENTS

https://docs.google.com/spreadsheets/d/1XVU7bji7iOgH8W9w9PLxDox44Da1R1oCxiSeoIztRGQ/edit?usp=sharing