Unit 9: Momentum and Collisions

Content Area: **Template**
Course(s):
Time Period:
Length:
Status: **Published**

State Mandated Topics Addressed in this Unit

This unit aligns with the following NJ Student Learning Standards for Science (NJSLS-S) and develops students' understanding of momentum, impulse, and force interactions:

NJSLS-S Performance Expectations:

- **HS-PS2-2**: Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
- **HS-PS2-3**: Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

Integrated Mathematics Standards (NJSLS-M):

- **A-CED.A.1**: Create equations and inequalities in one variable and use them to solve problems.
- **A-SSE.A.1**: Interpret expressions that represent a quantity in terms of its context.
- **F-IF.B.6**: Calculate and interpret the average rate of change of a function over a specified interval.

Science & Engineering Practices (SEPs):

- SEP 2: Developing and Using Models
- SEP 3: Planning and Carrying Out Investigations
- SEP 4: Analyzing and Interpreting Data
- SEP 5: Using Mathematics and Computational Thinking
- SEP 6: Constructing Explanations and Designing Solutions
- SEP 7: Engaging in Argument from Evidence

Crosscutting Concepts:

- Cause and Effect
- Energy and Matter
- Systems and System Models

These standards support instructional objectives including:

- Defining and calculating momentum and impulse

- Analyzing momentum changes during collisions
- Modeling elastic and inelastic collisions using data
- Investigating the role of time and force in collision impact
- Designing safety solutions using momentum principles

Unit Summary

This unit focuses on the concepts of momentum and impulse and their application to real-world interactions between objects. Students will investigate how the motion of objects is affected during collisions and apply the principles of conservation of momentum to both elastic and inelastic collisions. They will calculate momentum, analyze changes in momentum, and interpret data to evaluate force, mass, and time relationships during impact events. Through inquiry-based investigations and modeling, students will also explore how engineering practices can be used to minimize forces in collision scenarios. Emphasis is placed on using mathematical reasoning, graphical analysis, and experimental design to deepen understanding of motion and force interactions in physical systems.

Learning Objectives

- How do engineers design safety features to reduce the impact force during collisions?
- How do force, time, and mass interact during impact events?
- How does impulse relate to changes in momentum over time?
- How is momentum conserved in collisions and what real-world examples illustrate this?
- What is momentum and impulse and how are they related?
- What is the difference between momentum and inertia?
- What's the difference between elastic and inelastic collisions, and how can they be modeled?
- Why does momentum have a role in the physical world?

Essential Skills

- Analyze real-world collisions (e.g., sports, vehicle impacts) using momentum concepts.
- Apply the impulse-momentum theorem to explain and solve collision problems.
- Calculate the momentum of an object using mass and velocity.
- Compare momentum in systems with different mass and velocity configurations.
- Define the impulse given to an object.
- Define the momentum of an object.
- Design or evaluate safety devices (e.g., airbags, helmets) that reduce impulse during collisions.

- Distinguish between elastic and inelastic collisions based on energy and momentum conservation.
- Interpret motion and force graphs to assess momentum change over time.
- Recognize that unbalanced forces change the momentum of an object.
- Use data and mathematical models to demonstrate conservation of momentum in closed systems.

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-PS2-2	Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
SCI.HS-PS2-3	Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

Instructional Tasks/Activities

- Common assessment chapter test
- Common assessment quiz
- Constructed response
- Do now's and/or exit slips
- Energy demonstrations assignment
- Energy introduction
- Exit Cards (answer to daily objective questions)
- Graphic organizers or models
- Guided practice
- Homework
- Homework
- Individual, small, and large group work
- Intro to Momentum
- Laboratory investigations within small groups
- Momentum virtual lab
- Review Activity
- Section Review Questions
- Skateboards and Momentum
- Study Guide Packets
- Vocabulary flash cards or map (word, picture, sentence, example)

Assessment Procedure

- • Flashcards and/or drill and practice
- • Inquiry based activities with reflective discussion
- • Laboratory groups
- • Lecture with note taking or guided notes
- • Online models and simulators
- • Power point presentations
- • Whole and small group discussions

Recommended Technology Activities

- Appropriate Content Specific Online Resource
- Chromebook
- Copy/Paste Content Specific Link Here
- Copy/Paste Content Specific Link Here
- Copy/Paste Content Specific Link Here
- Gimkit
- GoGuardian
- Google Classroom
- Google Docs
- Google Forms
- Google Slides
- Kahoot
- MagicSchool AI
- Other- Specified in Lesson
- Quiziz
- Screencastify

Accommodations & Modifications & Differentiation

Accommodations and Modifications should be used to meet individual needs. Their IEP and 504 plans should be used in addition to the following suggestions.

Gifted and Talented

- Compare & Contrast
- Conferencing
- Debates
- Jigsaw

- Peer Partner Learning
- Problem Solving
- Structured Controversy
- Think, Pair, Share
- Tutorial Groups

Instruction/Materials

- alter format of materials (type/highlight, etc.)
- color code materials
- eliminate answers
- extended time
- extended time
- large print
- modified quiz
- modified test
- Modify Assignments as Needed
- Modify/Repeat/Model directions
- necessary assignments only
- Other (specify in plans)
- other- named in lesson
- provide assistance and cues for transitions
- provide daily assignment list
- read class materials orally
- reduce work load
- shorten assignments
- study guide/outline
- utilize multi-sensory modes to reinforce instruction

Environment

- alter physical room environment
- assign peer tutors/work buddies/note takers
- assign preferential seating
- individualized instruction/small group
- modify student schedule (Describe)
- other- please specify in plans
- provide desktop list/formula

Honors Modifications

Resources

- Resource 1
- Resource 2
- Resource 3
- Resource 4
- Resource 5