Unit 2 - Force and Motion/Force and Motion Engineering Internship

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

Unit Overview

Students plan and conduct investigations with physical materials, use digital models, and obtain information from science texts to investigate the relationships between force, change in velocity, and mass and discover the equal and opposite forces exerted during collisions (cause and effect). They construct visual models and explanations about what happened during a collision between a pod and a space station.

Enduring Understandings

A force is required to change the velocity of an object. How an object changes velocity depends on the direction of the force exerted on that object.
A stronger force can cause a greater change in velocity. Understanding a cause-and-effect relationship can help you infer what led to a particular result.
If the same strength force is exerted on two objects but the objects have different masses, the object with less mass will have a greater change in velocity.
When two objects collide, a force is exerted on each object. The two forces are exerted in opposite directions, but they are the same strength.
Even though the force exerted on each object in a collision is the same strength, if the objects have different masses, their changes in velocity will be different.

Essential Questions

How do forces affect motion?
What makes an object's motion change?
What causes some velocity changes to be greater than others?
If the same strength force is exerted on two objects, why might they be affected differently?
What are the forces like in a collision?
In a collision, how do the forces affect the objects?

Learning Objectives

A force is required to change the velocity of an object.
How an object changes velocity depends on the direction of the force exerted on that object.
A stronger force can cause a greater change in velocity.
Understanding a cause-and-effect relationship can help you infer what led to a particular result.
If the same strength force is exerted on two objects but the objects have different masses, the object with less mass will have a greater change in velocity.

When two objects collide, a force is exerted on each object. The two forces are exerted in opposite directions, but they are the same strength.
Even though the force exerted on each object in a collision is the same strength, if the objects have different masses, their changes in velocity will be different.
Engineers design plans, physical objects, and processes that try to solve human problems.
When an object falls and hits the ground, a collision occurs. The ground exerts a force on the object, and the object exerts a force on the ground. These are called impact forces.
Collisions involve a force acting between the objects for some amount of time.
Increasing the time over which a collision occurs can decrease the damage to an object because it spreads out the force over a long period of time.
Three factors affect the size of the forces when two objects hit each other: how long the collision lasts, the velocity on impact, and the mass of each object.
Engineers analyze the data from testing in order to improve upon their designs.
One kind of collision involves objects being pulled to Earth by gravity and hitting the ground.
Explore ways to change the motion of objects, and test the effect of forces of different strength, using physical materials (spring-launchers, balls, jar lids) and the Simulation.
Write and create visual models showing possible causes of the pod reversing direction.
Test the effects of changing the mass of an object on which a force acts, in both physical experiments and in the Sim.
Make visual models showing what would have happened if the pod were more or less massive than usual.
Investigate collisions using balls and with the Sim.
Use the Reasoning Tool to write about equal and opposite forces in a collision, and they model the effect of the collision between the pod and the space station on each object.
Conduct physical “egg-drop” tests to learn more about important variables.
Build digital supply pods, test them, analyze the results, and then plan another iteration to test.
Learn the value of iterative tests, how to balance trade-offs, and how to analyze the results in order to inform their next decisions.
Gather evidence and write proposals, supporting their claim about an optimal solution.
Relate the idea of gravity as an attractive force that acts at a distance to their designs.
Career Exploration - Examine careers in Science & Engineering.
Science Innovators Scrapbook Project. (Lessons satisfy the following legislative requirements: DEI, LGBTQIA+ & People w/ Disabilities, AAPI, Climate Change, and Amistad.

Standards: Content

Standards: Interdisciplinary

MS-PS2-1	Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.
MS-PS2-2	Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.
MS-PS2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
MS-PS3-1	Construct and interpret graphical displays of data to describe the relationships of kinetic

	energy to the mass of an object and to the speed of an object.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Assessment Evidence

Formative	Teacher observations, Class discussions, Lab Activities, Key concepts and vocabulary quizzes, Warm Ups, Open Ended Responses, Modeling, Simulations, Innovators Monthly Research
Summative	In correlation with the NJSLS, students must demonstrate the following as summative assessments: MS-PS2-1. Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects. MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. Other summative assessments will include but are not limited to: projects, summative tests, lab skills demonstrations, vocabulary quizzes, and designs for Science Fair projects.
Alternative & Benchmark	Alternative assessments as required by student IEP/504/I&RS- Read to the student and chart oral responses. Word banks, sentence frames, oral responses, graphic organizers, observations, orally administered assessments, and anecdotal notes. Benchmark – LinkIt Benchmark Assessment, Teacher Generated Assessments
Assessment Evidence Resource	

Instructional Resources

Smartboard, Computers, Websites and digital interactives/models, Multi-media presentations, Video Streaming, Amplify Digital Curriculum, Generation Genius, BrainPop, Microsoft 365, Primary and Secondary

Source Documents, Lab Materials as needed, Amplify Readings, Labs, Simulations

Instructional Resource List

Curricular Mandates

Below are the curricular requirements as defined in NJ Administrative Code and Statute

X	Amistad	X	Diversity, Equity, and Inclusion
X	Holocaust	X	LGBT and Disabilities (Grades 6-12)
X	Climate Change	X	Asian American & Pacific Islander

Social Emotional Learning (SEL) Competencies

NJ Social and Emotional Learning Competencies & Sub-Competencies

	Self-Awareness		Relationship Skills
X	Responsible Decision-Making	X	Social Awareness
X	Self-Management		

21st Century Skills & Themes

X	Global and Cultural Awareness	X	Technology Literacy		Planning and Budgeting
X	Creativity and Innovation		Financial Institutions		Risk Management and Insurance
X	Information and Media Literacy		Digital Citizenship		Economic and Government Influences
X	Critical Thinking and Problem Solving		Credit Profile		Career Awareness and Planning
	Civic Financial Responsibility		Financial Psychology		