Unit: Forces and Energy

Content Area: **Science**
Course(s): **Integrated Science 8**
Time Period: **1 marking period**
Length: **12 Weeks**
Status: **Published**

Unit Overview

Students will learn about the motion of objects and about he forces involved when objects in motion interact.

Students will learn about the forces of gravity, electricity, and magnetism.

Observe different kinds of energy and how it is stored, transferred, and transformed within a system.

Investigate different phenomena related to temperature and heat.

Transfer

By coming to understand how forces affect living and nonliving objects, you can explain many different phenomena in a world in motion.

There are forces that act on everyone and everything around you, but you cannot see them. These forces cause Earth to revolve around the sun, as well as the motors on machines to run.

Two forms of energy, potential and kinetic, can help to explain and predict changes in motion in all kinds of objects. This includes the movement of things as large as an airplane landing and as small as your body as you glide down a slide.

There are many ways you can use the terms temperature and heat to describe and measure more phenomena than the outside temperature.

Meaning

Understandings

Students will understand...

Chapter 1:

The motion of objects and how this motion can change

The forces involved when objects in motion interact

How to test design improvements for go-carts that wll increase their safety duirng a collision

Chapter 2:

The forces of gravity, electricity, and magnetism

How these forces interact with objects to cause many familiar effects and patterns seen in everyday life

How to analyze a drone's motor in order to explain how electromagnetism helps it maintain flight

Chapter 3:

Different kinds of energy and how that energy is stored, transferred and trandformed within a system

How to analyze the different parts of a Rube Goldberg machine and determine their functions

Chapter 4:

How to investigate different phenomena related to temperature and heat

How energy, heat and matter are related

How to create a device that can withstand extreme temperatures

Essential Questions

Chapter 1

- How do scientists and engineers describe motion?
- What forces exist between interacting objects?

- How do forces affect motion?

Chapter 2

- What is gravity?
- What is electricity?
- What are magnets?

Chapter 3

- What is energy?
- How much kinetic energy do moving objects have?
- How is energy stored?

Chapter 4

- How does energy affect temperature?
- How does heat affect matter?

Application of Knowledge and Skill

Students will know...

Chapter 1:

About the motion of objects and how this motion can change

About the forces involved when objects in motion interact

How to test design improvements for go-carts that wll increase their safety duirng a collision

Chapter 2:

About the forces of gravity, electricity, and magnetism

About how these forces interact with objects to cause many familiar effects and patterns seen in everyday life

How to analyze a drone's motor in order to explain how electromagnetism helps it maintain flight

Chapter 3:

Different kinds of energy and how that energy is stored, transferred and transformed within a system

How to analyze the different parts of a Rube Goldberg machine and determine their functions

Chapter 4:

How to investigate different phenomena related to temperature and heat

How energy, heat and matter are related

How to create a device that can withstand extreme temperatures

Students will be skilled at...

- Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons) and other media that will be useful in answering a scientific question.
- Develop models that will describe various scientific phenomena
- Make observations from several sources to construct an evidence-based account for natural phenomena.
- Compare and critique multiple solutions to a problem.
- Analyze data to determine if tests and/or tools are working as intended.
- Observe, graph, and construct explanations of various scientific phenomena relating to forces and motion.

Academic Vocabulary

Learning Goal 1 (Chapter 1)

Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

SCI.MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
SCI.MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

SCI.MS-PS2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

Target 1 (Lesson 4)

Understand the forces involved in collisions and use Newton's Laws in order to make design decisions.

Target 2 (Lesson 5)

Determine how the mass and speed of a cart affects the forces involved in collisions.

Learning Goal 2 (Chapter 1)

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.

SCI.MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
SCI.MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
SCI.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.

Target 1 (Lesson 1)

Explore a variety of concepts including reference frames, velocity, and acceleration and discover how they are connected.

Target 2 (Lesson 2)

Model forces and calculate the force needed to lift certain objects.

Target 3 (Lesson 3)

Explore Newton's first and second laws, and use them to design a game.

Learning Goal 3 (Chapter 2)

Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

SCI.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.
SCI.MS-PS2-3	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

Target 1 (Lesson 3)

Students investigate magnetic fields, build electromagnets and motors, and improve designs.

Learning Goal 4 (Chapter 2)

Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

SCI.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.
SCI.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.

Target 1 (Lesson 1)

Investigate how mass affects gravitational force by using simulations and drawings to understand gravitational forces and fields.

Learning Goal 5 (Chapter 2)

Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

SCI.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.
SCI.MS-PS2-5	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Target 1 (Lesson 2)

Discover electric charges and the forces involved in static electricity. Students will model electric fields and describe electric currents and electric circuits.

Target 2 (Lesson 3)

Students investigate magnetic fields, build electromagnets and motors, and improve designs.

Target 3 (Lesson 4)

Evaluate how gravity, mass, and electromagnetism affect the flight of an object.

Learning Goal 6 (Chapter 3)

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

SCI.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.
SCI.MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

SCI.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.

Target 1 (Lesson 2)

Observe and graph relationships between kinetic energy, mass, and speed.

Target 2 (Lesson 4)

Design musical instruments based on principles of energy conservation, transfer, and transformation.

Learning Goal 7 (Chapter 3)

Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

SCI.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.
SCI.MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
SCI.MS-PS3-2	Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

Target 1 (Lesson 1)

Create a model of potential and kinetic energy, then investigate the transformations between potential and kinetic energy and revise your model.

Target 2 (Lesson 3)

Model gravitational potential energy changes using a simulation.

Target 3 (Lesson 4)

Design musical instruments based on principles of energy conservation, transfer, and transformation.

Learning Goal 8 (Chapter 4)

Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

SCI.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.
SCI.MS-PS3-3	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

Target 1 (Lesson 3)

Put together what you've learned in this unit to design, construct, and test a thermos that can be used in a desert.

Learning Goal 9 (Chapter 4)

Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

SCI.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.
SCI.MS-PS3-4	Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

Target 1 (Lesson 1)

Understand how temperature change depends on the masses of matter, types of matter, and states of matter and how this applies to conduction, convection and radiation.

Target 2 (Lesson 2)

Understand how to use a conductometer to measure thermal conductivty in order to compare the heat capacities and temperature changes of different substances.

Learning Goal 10 (Chapter 3, 4)

SCI.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.
SCI.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.
SCI.MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
SCI.MS-PS3-5	Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Target 1 (Ch 3, Lesson 5)

Understand the transfers and transformations of energy involved in chain reactions.

Target 2 (Ch 4, Lesson 2)

Investigate thermal conductivity in order to compare the heat capacities of different materials.

Target 3 (Ch 4, Lesson 3)

Apply knowledge of thermal conductivty and heat capacities to design an object that can maintain a constant temperature.

Formative Assessment and Performance Opportunities

Ch.1 Evaluating modern Go-Carts

Ch. 2 Investigating a drone motor design

Ch. 3 Analyzing a chain reaction machine

Ch. 4 Designing, constructing, and testing a thermos

Lesson Game

Students test their understanding of key concepts with an educational game.

Interactive Tutorial

Students can work independently to check their understanding in a safe environment that provides instant feedback but is not graded.

Interactive Student Notebook

Students record their understanding of both the reading and activity. Review during the lesson to gauge student understanding.

Vocabulary Cards

Students check their understanding of key vocabulary terms with digital flip cards.

Class Participation/Discussion Questions

Throughout the lesson students will have opportunities embedded in the lesson to check for student understanding.

Summative Assessment

NJSLS-Science Designed Lesson Assessments

- Describing motion
- Forces in interactions
- Effects on forces
- Gravity
- Electricity
- Magnetism and Electromagnetism
- Forms of energy
- Measuring kinetic energy
- Potential energy in systems
- Thermal energy and heat
- Thermal properties of matter

Accommodations/Modifications

Quicker Coverage

Skip an Activity In Investigation 1, students are asked to draw a picture involving reference frames. For quicker coverage, skip the drawing activity. Alternatively, if students are struggling to understand reference frames, do the drawing activity and skip the paperclip activity that follows it.

Conduct Class Discussions If you are unable to find a location for the velocity game in Investigation 2, or you are running out of time, conduct a class discussion instead. Students can discuss a plan for how they would demonstrate a velocity of 4 m/s in five different ways. Additionally, in Investigation 3, students could conduct a class discussion in place of the drawing activity.

Skip Making Predictions For quicker coverage, in Investigation 1, you could skip the part where students make predictions about what factors might affect electric force before they do the experiments.

Deeper Coverage

Assimilate Lesson Content In Investigation 3, students draw two scenarios with different accelerations. Have students also identify the reference frame that they are using to view the situation. Additionally, they should identify a reference point to compare the object's motion to. Volunteers can present their answers to the class to be discussed.

Conduct an Internet Search Suggest to students that they can come up with a question about electric rays and do a short research project (internet search) to answer it. Then, students can work in groups and present their findings to one another.

Experiment with Conductors and Insulators Have students bring in items from home: one insulator and one conductor. Then, they test these items using the circuit kit materials during the next class. They connect each item within the circuit and see if the LED is still able to light up. Safety Note: do not connect electronic devices such as cell phones. Do not allow other items that could be damaged by the current.

English Language Learners

Practice Vocabulary In Investigation 1, have students practice saying additional phrases regarding the positions of the animals. Have them identify which animal is the reference point in each case. For example,

“The rabbit is about a foot to the left of the bird. In that case, the bird is the reference point.”

At the end of Investigation 3, conduct a vocabulary review. Use the bold terms from the student text. Students can work in pairs, taking turns saying the definitions aloud.

Make Connections to Vocabulary Discuss alternate meanings of the words *resistance*, *repulsive*, *current*, and *force*, and how they relate to the scientific meanings. For example, if protesters act in resistance against a political outcome, they oppose it. Similarly, a material with high resistance opposes the flow of charge. Have students use these words in sentences, including a sentence for the alternate meaning and a sentence for the scientific meaning. While the relationships for these terms are obvious, some are not; students can research the origins of the words *electric*, *charge,* and *field*.

Learners Reading and Writing Below Grade Level

Practice Writing and Revising At the end of Investigation 1, read the Wrap Up questions to students out loud. After each question, have students write down what they think the answer is. Go over the answers as a class. Then, have students trade and revise each others’ answers as needed.

Conduct a Class Discussion In Investigation 2, the interactive student notebook includes a lengthy explanation about how bees use electric fields to find the best flowers. Students are asked to create a model of the electric charges on the bees and flowers in the simulation. Have students read the paragraph, and conduct a class discussion as a follow-up. Ensure students have grasped the concepts before they attempt to model the situation in the simulation.

Learners with Special Education Needs

Conduct a Class Discussion If students are unable to play the velocity game, conduct a class discussion about how they would demonstrate motion instead. They do not need to carry out the movements.

Work As a Class In Investigation 2, students are instructed to work in pairs and use the simulation to answer the notebook questions. Rather than working in pairs, work together as a class to provide guidance through the simulation. Answers can be given orally rather than written in the student notebook.

Advanced Learners

Construct Graphs Have students construct graphs of position versus time for an object moving with constant velocity and an object that is accelerating. Allow students to come up with their own data for the graphs. The position versus time graph for constant velocity should be a straight diagonal line, while the position versus time graph for acceleration should be a curve. Discuss the graphs as a class.

Conduct an Investigation Students can use the school library to find out what voltage is. They should

investigate how voltage relates to batteries and electrical circuits. Using materials from the kit, challenge students to build two circuits with two different voltage sources (batteries). They should explain how the different voltage sources affect the circuits.

Unit Resources

- TCI Online Manual/Materials
- Vocabulary Cards
- TCI Kit
- Student Textbook

21st Century Life and Careers

CRP.K-12.CRP1.1	Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.
CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
CRP.K-12.CRP5.1	Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.
CRP.K-12.CRP6.1	Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.
CRP.K-12.CRP7.1	Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.

CRP.K-12.CRP8.1	Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.
CRP.K-12.CRP11.1	Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.

Interdisciplinary Connections

LA.W.8.1.A	Introduce claim(s), acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
LA.W.8.1.B	Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
LA.W.8.1.C	Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
LA.W.8.1.E	Provide a concluding statement or section that follows from and supports the argument presented.
LA.W.8.2.A	Introduce a topic and organize ideas, concepts, and information, using text structures (e.g., definition, classification, comparison/contrast, cause/effect, etc.) and text features (e.g., headings, graphics, and multimedia).
LA.W.8.2.B	Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
LA.W.8.2.C	Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
LA.RI.8.1	Cite the textual evidence and make relevant connections that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
LA.RI.8.2	Determine a central idea of a text and analyze its development over the course of the text, including its relationship to supporting ideas; provide an objective summary of the text.
LA.RI.8.3	Analyze how a text makes connections among and distinctions between individuals, ideas, or events (e.g., through comparisons, analogies, or categories).
LA.RI.8.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.
MA.6.EE.A.3	Apply the properties of operations to generate equivalent expressions.
MA.6.EE.A.4	Identify when two expressions are equivalent (i.e., when the two expressions name the same number regardless of which value is substituted into them).
MA.6.EE.B.6	Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.
MA.6.EE.C.9	Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables

	using graphs and tables, and relate these to the equation.
MA.6.RP.A.3b	Solve unit rate problems including those involving unit pricing and constant speed.
MA.6.RP.A.3d	Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.
MA.8.F.A.2	Compare properties (e.g. rate of change, intercepts, domain and range) of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
MA.8.EE.A.3	Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other.
MA.8.EE.A.4	Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.