# Unit 02: Changes in Movement

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

## Standards Alignment

## New Jersey Student Learning Standards

**Practice 1. Asking questions (for science) and defining problems (for engineering)**
**Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.**

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.

**Practice 2. Developing and using models**
**Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.**

Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.

Design a test of a model to ascertain its reliability.

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

**Practice 3. Planning and carrying out investigations**
**Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.**

Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence

as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.

Select appropriate tools to collect, record, analyze, and evaluate data.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

**Practice 4. Analyzing and interpreting data**
**Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.**

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

**Practice 5. Using mathematics and computational thinking**
**Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.**

Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

**Practice 6. Constructing explanations (for science) and designing solutions (for engineering)**
**Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.**

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural
world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

**Practice 7. Engaging in argument from evidence**
**Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.**

Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new

evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

**Practice 8. Obtaining, evaluating, and communicating information**
**Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.**

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

| | |
|---|---|
| | Key Ideas and Details |
| LA.K-12.NJSLSA.R1 | Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. |
| LA.K-12.NJSLSA.R2 | Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. |
| LA.K-12.NJSLSA.R3 | Analyze how and why individuals, events, and ideas develop and interact over the course of a text. |
| | Craft and Structure |
| LA.K-12.NJSLSA.R4 | Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone. |
| LA.K-12.NJSLSA.R6 | Assess how point of view or purpose shapes the content and style of a text. |
| LA.K-12.NJSLSA.R8 | Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence. |
| LA.K-12.NJSLSA.R9 | Analyze and reflect on how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take. |
| LA.K-12.NJSLSA.R10 | Read and comprehend complex literary and informational texts independently and proficiently with scaffolding as needed. |
| LA.RST.11-12 | Reading Science and Technical Subjects |
| 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.11-12.2 | Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. |
| LA.RST.11-12.3 | Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. |

| | |
|---|---|
| LA.RST.11-12.4 | Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. |
| LA.RST.11-12.6 | Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved. |
| LA.RST.11-12.8 | Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. |
| 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. |
| LA.RST.11-12.10 | By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. |
| SCI.HS-ETS1 | Engineering Design |
| 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-PS3 | Energy |
| SCI.HS-PS3-3 | Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. |
| SCI.HS-PS3-1 | Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. |

## Integration of Career Readiness, Life Literacies and Key Skills

| | |
|---|---|
| CRP.K-12.CRP1 | Act as a responsible and contributing citizen and employee. |
| CRP.K-12.CRP2 | Apply appropriate academic and technical skills. |
| CRP.K-12.CRP3 | Attend to personal health and financial well-being. |
| CRP.K-12.CRP4 | Communicate clearly and effectively and with reason. |
| CRP.K-12.CRP5 | Consider the environmental, social and economic impacts of decisions. |
| CRP.K-12.CRP6 | Demonstrate creativity and innovation. |
| CRP.K-12.CRP7 | Employ valid and reliable research strategies. |
| CRP.K-12.CRP8 | Utilize critical thinking to make sense of problems and persevere in solving them. |
| CRP.K-12.CRP9 | Model integrity, ethical leadership and effective management. |
| CRP.K-12.CRP10 | Plan education and career paths aligned to personal goals. |
| CRP.K-12.CRP11 | Use technology to enhance productivity. |
| CRP.K-12.CRP12 | Work productively in teams while using cultural global competence. |

## Technology / Integration of Computer Science and Design Thinking

## Interdisciplinary Connections: NJSLS for ELA, Social Studies, Science and/or Math

## Section

## Integration of Diversity, Equity and Inclusion; Climate Change; Informational and Media LiteracyNew Section

see Crosswalks

## 21st Century Life and Careers

## Stage I: Desired Results

## Transfer/Overview/Rationale

| Transfer / Overview / Rationale |
| --- |
| Unit Rationale<br>The purpose of this unit… |

## Meaning

## Essential Questions

Essential Questions

How do forces impact life?

How are rates encountered in everyday life?

Why is math essential to the understanding of science?

How does design impact strength?

Are there alternative forms of energy that will serve societies needs?

## Enduring Understanding/Indicators of Understanding

Enduring Understanding/Indicators of Understanding

Forces cause change in motion and surround us in everyday life.

Events involving rates are encountered everyday.

Mathematics often is essential for the understanding of technology use.

Design influences strength

Alternative energy, such as solar energy, is a viable fuel source to meet societies needs.

## Acquisition (Student Learning Objectives)

## Knowledge

Knowledge

Students will know…

Students will know the following:

- speed is a rate
- speed and velocity are related
- speed is a scalar
- velocity is a vector
- speed is calculated using distance moved and time elapsed
- acceleration is the rate of change of velocity
- stored energy can be transformed to cause movement
- Newton's three laws of motion
- difference between kinetic and potential energy
- the Law of the Conservation of Energy
- types of friction
- rotational inertia
- wheel to axle ratio
- the relationship between mass and weight
- electricity
- electrons
- protons
- photovoltaic cells
- boron and silicon layers
- negative
- positive
- power source
- power
- amp
- current
- voltage
- volts
- ohms
- resistance
- watts
- series circuits
- parallel circuits
- electron flow
- motor
- gears
- axles
- intensity

## Skills

Skills

Student will be skilled at …

Students will be able to do the following:

- identify speed versus velocity
- calculate linear rate
- manipulate the rate formula to solve for an unknown
- convert between rate units
- calculate linear acceleration
- construct a mousetrap powered car
- use a mousetrap powered car to perform distance, accuracy and speed tests
- write a formal laboratory report
- identify Newton's three law of motion
- identify kinetic and potential energy in a system
- identify different types of friction
- use wheel to axle ratio to design the mousetrap powered car
- differentiate between electrons and protons
- determine the difference between elements
- identify the silicon and phosphorus layers of a solar cell
- describe how a solar panel works
- differentiate between the various electrical terms
- solve for voltage using current and resistance
- differentiate between a series and a parallel circuit
- safely use a soldering iron
- construct a testable solar car
- use a solar car to complete speed and accuracy trials
- complete a crossword using solar vehicle terms

## Stage 3: Learning Plan

## Resource and Mentor Texts

Resources and Mentor Texts

Gonick, Larry & Art Huffman. The Cartoon Guide to Physics. HarperCollins Publishers, 1990.

Doc Fizzix's MTPC guide

Lecture Notes

Mousetrap Powered Car Kits, Dr Fizzix

Design Considerations & Construction Tips, Dr Fizzix

All Wound Up Lab ~ Doc Fizzix

The Force is Against You Lab ~ Doc Fizzix

How do photovoltaic solar cells work? You tube ~
http://www.youtube.com/results?search_query=how+does+a+solar+panel+work&aq=0

ECO Solarcar Racer ~ Kelvin School Projects

Optimum Angle Lab ~ Doc Fizzix

Area vs. Velocity Lab ~ Doc Fizzix

Wall Hugging Mouse (background)

Lego mindstorms (background)

2. WH Mouse2.pdf
mindstorms.pdf

## Formative Assessment Strategies

Formative Assessment Strategies

MTPC Pre-quiz

MTPC Pre-questions (Math Packet)

Solar Cars Pre-quiz

Electrostatics Pre-questions (Math Packet)

Teacher observations/questions during construction

Solar Vehicles Pretest.docx
Mouse Trap Powered Cars.doc

## Learning Activities/Unit of Study

Learning Activities/Unit of Study

***Mousetrap Powered Cars***

Day1:

- Do Now ~ Portfolio discussion
- MTPC:
- ***Pre-test
- ***Notes ~ Intro, stages of design, Newton's 1st Law
- ***Construction

Day 2:

- MTPC:
- ***Notes ~ Newton's 2nd Law, Newton's 3rd Law, Rotational Inertia
- ***Construction

Day 3:

- MTPC:
- ***Notes ~ Energy, Power, Wheel-to-Axle ratio
- ***Construction

Day 4:

- MTPC:
- ***Notes ~ wheel to axle ratio, types of friction
- ***Construction

Day 5:

- MTPC:
- ***Notes ~ types of friction, velocity & acceleration
- ***Construction

Day 6:

- Formal Lab Report:
- *Library
- ***Complete title, purpose, hypothesis, materials, procedure (1st half)
- *Submit for comments/editing

Day 7:

- MTPC:
- ***Quiz ~ MTPC basics
- ***Construction

Day 8:

- Running Physics Lab

Day 9:

- Quiz ~ Speed/Velocity
- MTPC:
- ***Investigation Journal
- ***Testing Distance, Speed, Accuracy

Day10:

- MTPC
- ***Testing Distance, Speed, Accuracy

Day 11:

- All Wound Up Lab
- The Force is Against You Lab

Day 12:

- The Force Against You Lab

Day 13:

- Formal Lab Report:
- *Library
- ***Finish title, purpose, hypothesis, materials, procedure (1st half)
- ***Work on procedure (2nd half), results, conclusion
- *Submit for comments/editing

***Solar Cars***

Day 14:

- Solar Cars pre-test
- Power of the Sun Video with Notes
- Notes:
- ***value of solar energy
- Construction
- ***Set-up workstations
- Begin planning

Day 15:

- Solar Cars
- ***Notes: background, solar energy, photovoltaic cells
- ***Construction

Day 16:

- Optimum Angle Lab

Day 17:

- Close reads ~ types of friction, types of circuits
- Solar Car Puzzles
- Construction ~ Solar Cars

Day 18:

- Solar Cars
- ***Notes ~ electrical terms, types of circuits
- ***Construction

Day 19:

- Solar Cars:
- ***Modifications
- ***Testing

Day 20:

- Area vs. Velocity Lab

Day 21:

- Quiz ~ Solar Cars
- Testing

Day 20:

- Discussion ~ Intro to Series/Parallel Circuits
- Practice Problems:
- ***Ohm's Law
- ***Series Circuits

Day 21:

- Practice Problems:
- ***Series Circuits (finish)
- ***Parallel Circuits
- ***Power (begin)

Day 22:

- Circuits Problems ~ finish
- Robots
- ***Set up workstation
- ***Construction (begin)

Day 23:

- Robots
- ***Construction

Day 24:

- Circuits Quiz
- Robots
- ***Construction
- Basic Testing/modifications

Day 25:

- Robots
- ***Construction ~ Finish
- Basic Testing/modifications

Day 26:

- Robots
- ***Testing

What's the deal with Solar Power.pptx

Graph Data in Excel Tutorial.docx

## Modifications and/or Accommodations

**Suggested Modifications (ELL, Sp. Ed, GIfted, At-risk of Failure)**

### English Language Learners

Native language support: The teacher provides auditory or written content to students in their native language.

Adjusted Speech: The teacher changes speech patterns to increase student comprehension. This could include facing the students, paraphrasing, clearly indicating the most important ideas, and speaking more slowly.

Visuals: The teacher uses graphics, pictures, visuals, and manipulatives. This helps ELL students better understand and comprehend the subjects at hand.

Front-Loading Vocabulary: The teacher front loads vocabulary. This means providing students with a list of important vocabulary words they will need to know for a book, lesson, etc. prior to the lesson being taught. Including pictures to go with the vocabulary words is also very beneficial for the students.

### Special Education Students

Chunking: The teacher presents information in a way that makes it easy for students to understand and remember. Chunking is based on the presumption that our working memory is easily overloaded by excessive detail. The best way to deliver information is to organize it into meaningful units. Because students with special needs get overloaded easily, chunking is an effective strategy to use with them.

Checking for Understanding: It is important to constantly check for understanding, especially for students who have accommodations. Teachers want to make sure students understand the concepts being covered in a way that makes sense to them.

Extra time: The teacher provides students with special needs extra time to complete work or answer questions. It is important to give students enough time to process their thoughts.

Oral Reading: The teacher will read work orally to students. Class work such as tests and literature circles may need to be read aloud to the student.

Timers: The teacher will use timers as an instructional tool. The use of timers is beneficial for students who have trouble completing tasks. Timers can be helpful so the student is aware of how much time they have to complete an assignment.

## Students with 504 Plans

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## Gifted & Talented Strategies

Extensions/Enrichments: Teachers will provide gifted and talented students with extension/enrichment projects. Students will be challenged to further their understanding, to apply acquired knowledge, and/or to produce something in reference to acquired knowledge.

Modify/Change Activities:  Teachers will monitor and modify activities to accommodate those students who need to be challenged further. Additional reading, problem-solving, writing, or project work is necessary for those students who are ready to move on at a rate more accelerated than their peers. In this way, G & T students are provided the same opportunity for support as special needs students.

## Students at Risk of School Failure

Directions or Instructions: Make sure directions and/or instructions are given in limited numbers. Give directions/instructions verbally and in simple written format. Ask students to repeat the instructions or directions to ensure understanding occurs. Check back with the student to ensure he/she hasn't forgotten.

Peer Support: Peers can help build confidence in other students by assisting in peer learning. Many teachers use the 'ask 3 before me' approach. This is fine, however, a student at risk may have to have a specific student or two to ask. Set this up for the student so he/she knows who to ask for clarification before going to you.

Alternate or Modified Assignments: Always ask yourself, "How can I modify this assignment to ensure the students at risk are able to complete it?" Sometimes you'll simplify the task, reduce the length of the assignment or allow for a different mode of delivery. For instance, many students may hand something in, the at-risk student may jot notes and give you the information verbally. Or, it just may be that you will need to assign an alternate assignment.

Increase One to One Time: When other students are working, always touch base with your students

at risk and find out if they're on track or needing some additional support. A few minutes here and there will go a long way to intervene as the need presents itself.

Contracts: It helps to have a working contract between you and your students at risk. This helps prioritize the tasks that need to be done and ensure completion happens. Each day write down what needs to be completed, as the tasks are done, provide a checkmark or happy face. The goal of using contracts is to eventually have the student come to you for completion sign-offs.

Hands On: As much as possible, think in concrete terms and provide hands-on tasks. This means a child doing math may require a calculator or counters. The child may need to tape record comprehension activities instead of writing them. A child may have to listen to a story being read instead of reading it him/herself.

Tests/Assessments: Tests can be done orally if need be. Break tests down in smaller increments by having a portion of the test in the morning, another portion after lunch and the final part the next day.

Seating: Seat students near a helping peer or with quick access to the teacher. Those with hearing or sight issues need to be close to the instruction which often means near the front.