

Unit 02: Fundamental Forces (6 Weeks)

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

Standards Alignment

New Jersey Student Learning Standards

PS2: Motion and Stability: Forces and Interactions

PS2.B: Types of Interactions

Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects.(HS-PS2-4)

Forces at a distance are explained by fields (gravitational,electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5)

Attraction and repulsion between electric charges at the atomicscale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.(HS-PS2-6),(secondary to HS-PS1-1),(secondary to HS-PS1-3)

SCI.3-PS2	Motion and Stability: Forces and Interactions
SCI.3.PS2.B	Types of Interactions
SCI.HS-PS2	Motion and Stability: Forces and Interactions
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-PS2-4	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

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

TECH.8.1.12	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
TECH.8.2.12	Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
TECH.8.2.12.D	Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.
TECH.8.2.12.D.1	Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.

Interdisciplinary Connections: NJSLs for ELA, Social Studies, Science and/or Math Section

LA.K-12.NJLSA.R	Reading Craft and Structure
LA.K-12.NJLSA.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. Integration of Knowledge and Ideas
LA.K-12.NJLSA.R7	Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.
LA.K-12.NJLSA.W	Writing Text Types and Purposes
LA.K-12.NJLSA.W1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
LA.K-12.NJLSA.W3	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
LA.RI.11-12.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

Production and Distribution of Writing

LA.K-12.NJSLSA.W4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
LA.RI.11-12.7	Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.
LA.W.11-12.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
LA.W.11-12.3	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
LA.W.11-12.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

Integration of Diversity, Equity and Inclusion; Climate Change; Informational and Media Literacy **New Section**

see Crosswalks

21st Century Life and Careers

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.CRP4.1	Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.
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.

Stage I: Desired Results

Transfer/Overview/Rationale

Transfer / Overview / Rationale

Unit Rationale

The purpose of this unit...

There are four basic forces that underlie the processes in nature but only two operate at a scale experienced by students. These forces drive interactions between objects as large as galaxies and as small as electrons.

Meaning

Essential Questions

Essential Questions

1. At what scales and/or situation does each fundamental force dominate?
2. How can a topographical map be used to model gravitational or electric fields?
3. How are electric and gravitational interactions different? The same?

Enduring Understanding/Indicators of Understanding

Enduring Understanding/Indicators of Understanding

Students will understand that:

1. Certain types of forces are considered fundamental.
2. A gravitational field is caused by an object with mass and an electric field is caused by an object with electric charge.
3. Coulomb's Law is the electrostatic equivalent of Newton's Law of Universal Gravitation

Acquisition (Student Learning Objectives)

Knowledge

Knowledge

Students will know...

- The four fundamental forces (gravitational, electromagnetic, strong nuclear, and weak nuclear)
- Gravitational forces are exerted at all scales and dominate at the largest distance and mass scales
- Electromagnetic forces are exerted at all scales and can dominate at the human scale
- The strong force is exerted at nuclear scales and dominates the interactions of nucleons.
- A vector field gives, as a function of position, the value of a physical quantity that is described by a vector.
- Gravitational force describes the interaction of one object with mass with another object with mass.
- A gravitational field g at the location of an object with mass m causes a gravitational force of magnitude mg to be exerted on the object in the direction of the field.
- The gravitational field caused by a spherically symmetric object with mass is radial and, outside the object, varies as the inverse square of the radial distance from the center of that object.
- Electric charge is conserved. The net charge of a system is equal to the sum of the charges of all the objects in the system.
- There are only two kinds of electric charge. Neutral objects or systems contain equal quantities of positive and negative charge.
- The smallest observed unit of charge that can be isolated is the electron charge, also known as the elementary charge.
- Electric force results from the interaction of one object that has an electric charge with another object that has an electric charge.

Skills

Skills

Student will be skilled at ...

- Applying $F=mg$ to calculate the gravitational force on an object with mass m in a gravitational field of strength g .
- Applying $g = GM/r^2$ to calculate the gravitational field due to an object with mass M , where the field is a vector directed toward the center of the object of mass M .
- Approximating a numerical value of the gravitational field near the surface of an object from its radius and mass relative to those of the Earth.
- Using Newton's law of gravitation to calculate the gravitational force two objects exert on each other.
- Connecting the concepts of gravitational force and electric force to compare similarities and differences between forces.
- Making claims about natural phenomenon based on conservation of electric charge.
- Making predictions using the conservation of electric charge, about the sign and relative quantity of net charge of objects or systems after various charging processes.
- Explaining the two charge model based on evidence produced through scientific practices.
- Challenging the claim that an electric charge smaller than the elementary charge has been isolated.
- Using Coulomb's law to qualitatively and quantitatively make predictions about the interaction between two electric point charges.

Stage 3: Learning Plan

Resource and Mentor Texts

Resources and Mentor Texts

- Giancoli, D.C. Physics: Principles with Applications. Englewood Cliffs, NJ: Pearson Education.
- New Jersey Center for Teaching and Learning
- Hieggelke, Curtis, David Maloney, and Stephen Kanim. Newtonian Tasks Inspired by Physics Education Research: nTIPERs. Upper Saddle River, NJ: Pearson, 2012
- PhET Interactive Simulations <https://phet.colorado.edu/en/simulations/category/physics>
- Cunningham, Herr, Hands On Physics Activities with Real World Applications
- Bilash, Maiullo A Demo a Day, A year of Physics Demonstrations
- Lewin Lectures on Physics
- Flipping Physics
- Doc Schuster Physics Videos

Formative Assessment Strategies

Formative Assessment Strategies

- Hand Signals - students use hand signals to indicate their understanding
- Misconception Check - students are presented with a common misconception about a concept and then asked to agree or disagree and explain why.
- Student Conference - one on one conversation with students to check for understanding
- Observation - observe students as they work to check for learning
- Choral Response - students respond verbally at the same time in response to a question
- Debriefing - students reflect on their work immediately following an activity
- Topic Assessment - short quiz to test a single topic

Learning Activities/Unit of Study

Learning Activities/Unit of Study

- Lecture
- Demonstrations
- Practice Problems -
- Informal activities - students manipulate materials to study a physical concept
- Inquiry Based Activities - students are presented a situation and must design and test their own solution
- Experimental Investigations - students follow a set procedure for studying a physical concept
- PhET Interactive simulations using chromebooks
- Review and practice skills using a variety of materials - (text, workbook, chromebook, games, activities, discussion)

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.