

# 2 Fundamental Forces

Content Area: **Science**  
Course(s): **Applied Physical Science**  
Time Period: **October**  
Length: **25**  
Status: **Published**

## Unit Overview:

---

In this unit of study, students plan and conduct investigations and apply scientific ideas to make sense of Newton's law of gravitation and Coulomb's Law. They apply these laws to describe and predict the gravitational and electrostatic forces between objects. The crosscutting concept of patterns is called out as an organizing concept for this disciplinary core idea. Students are expected to demonstrate proficiency in planning and conducting investigations and applying scientific ideas to demonstrate an understanding of core ideas.

## Enduring Understandings:

---

- A force is not required to keep an object in motion
- Acceleration is directly proportional to force and inversely proportional to mass
- Gravity is a very weak force as compared to the electromagnetic force
- The electromagnetic force describes the interaction of charged particles, and gravity describes the interaction between masses
- The mass of an object is a measure of its inertia and is independent of the object's external environment.
- The strong and weak forces are important in describing nuclear reactions
- The weight of an object is the gravitational force exerted on that object. The weight of an object depends upon its external environment.

## Essential Questions:

---

- How can one explain and predict interactions between objects and within systems of objects?
- How does the weight (force of gravity) of an astronaut of a specific mass (100 kg including gear) change at specific distances from Earth as the shuttle flies toward the moon?
- How far away can my finger be from my sister or brother if I want to zap them with static electricity?

## Standards/Indicators/Student Learning Objectives (SLOs):

---

- SWBAT compare and contrast newton's gravity and einstein's gravity
- SWBAT discuss the EM force and use coulombs equation to model the universe
- SWBAT list the fundamental forces of the universe in order of strength
- SWBAT use newton's gravity equation to model the universe

|                       |  |
|-----------------------|--|
| 9-12.HS-PS2-5         | Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.  |
| 9-12.HS-PS2-5.3.1     | Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. |
| 9-12.HS-PS2-5.PS2.B.1 | 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.  |
| 9-12.HS-PS2-4.PS2.B.2 | 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.  |

## Lesson Titles:

---

- Einstein's Gravity
- EM Force
- Newton's Gravity
- Nuclear Forces

## Career Readiness, Life Literacies & Key Skills

---

|              |  |
|--------------|--|
| WRK.K-12.P.1 | Act as a responsible and contributing community members and employee.                      |
| WRK.K-12.P.4 | Demonstrate creativity and innovation.   |
| WRK.K-12.P.5 | Utilize critical thinking to make sense of problems and persevere in solving them.         |
| WRK.K-12.P.8 | Use technology to enhance productivity increase collaboration and communicate effectively. |
| WRK.K-12.P.9 | Work productively in teams while using cultural/global competence.                         |

## Inter-Disciplinary Connections:

---

|               |  |
|---------------|--|
| LA.RH.11-12.1 | Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.), to support analysis of primary and secondary sources, connecting insights gained from specific details to develop an understanding of the text as a whole. |
| LA.RH.11-12.2 | Determine the theme, central ideas, information and/or perspective(s) presented in a primary or secondary source; provide an accurate summary of how key events, ideas and/or author's perspective(s) develop over the course of the text.                       |
| LA.RH.11-12.3 | Evaluate various perspectives for actions or events; determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain.  |
| LA.RH.11-12.4 | Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).                          |
| LA.RH.11-12.6 | Evaluate authors' differing perspectives on the same historical event or issue by assessing the authors' claims, reasoning, and evidence.  |

|                 |   |
|-----------------|---|
| MA.N-Q.A.1      | Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.   |
| MA.N-Q.A.2      | Define appropriate quantities for the purpose of descriptive modeling.  |
| LA.RH.11-12.7   | Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, qualitatively, as well as in words) in order to address a question or solve a problem.   |
| LA.RH.11-12.8   | Evaluate an author's claims, reasoning, and evidence by corroborating or challenging them with other sources.   |
| MA.N-Q.A.3      | Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.   |
| LA.RH.11-12.9   | Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.  |
| 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.  |
| MA.N-VM.A.1     | Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., $\mathbf{v}$ , $ \mathbf{v} $ , $  \mathbf{v}  $ , $v$ ).  |
| MA.N-VM.B.5     | Multiply a vector by a scalar.  |
| LA.WHST.11-12.4 | Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.  |
| LA.WHST.11-12.5 | Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.  |
| LA.WHST.11-12.6 | <p>Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.</p> <p>An expression is a record of a computation with numbers, symbols that represent numbers, arithmetic operations, exponentiation, and, at more advanced levels, the operation of evaluating a function. Conventions about the use of parentheses and the order of operations assure that each expression is unambiguous. Creating an expression that describes a computation involving a general quantity requires the ability to express the computation in general terms, abstracting from specific instances.</p> <p>An equation is a statement of equality between two expressions, often viewed as a question asking for which values of the variables the expressions on either side are in fact equal. These values are the solutions to the equation. An identity, in contrast, is true for all values of the variables; identities are often developed by rewriting an expression in an equivalent form.</p> <p>Algebraic manipulations are governed by the properties of operations and exponents, and the conventions of algebraic notation. At times, an expression is the result of applying operations to simpler expressions. For example, <math>p + 0.05p</math> is the sum of the simpler expressions <math>p</math> and <math>0.05p</math>. Viewing an expression as the result of operation on simpler expressions can sometimes clarify its underlying structure.</p> <p>The same solution techniques used to solve equations can be used to rearrange formulas. For example, the formula for the area of a trapezoid, <math>A = ((b_1 + b_2)h)/2</math>, can be solved for <math>h</math> using the same deductive process.</p> <p>The solutions of an equation in one variable form a set of numbers; the solutions of an equation in two variables form a set of ordered pairs of numbers, which can be plotted in</p> |

the coordinate plane. Two or more equations and/or inequalities form a system. A solution for such a system must satisfy every equation and inequality in the system.

## **Instructional Strategies, Learning Activities, and Levels of Blooms/DOK:**

---

- Electrostatics interactive models
- Coloumb's math practice
- Coloumb's Notes
- Graphical Relationships in Electric Fields
- Gravity Force Lab
- Gravity Math practice
- Newton's Gravity Notes
- Nuclear Forces Notes
- Nuclear Forces practice

## **Modifications**

---

### **ELL Modifications:**

---

- Focus on domain specific vocabulary and keywords
- Front load information
- Group students
- Provide ELL students with multiple literacy strategies
- Sheltered English Instruction
- Use real objects when possible

### **IEP & 504 Modifications:**

---

- less none of the above, all of the above, which of the following apply, or which do not apply type questions (again it is testing for understanding of the question not the content)
- providing students with content vocabulary prior to teaching a lesson including that vocabulary (pre-teaching)
- providing study guides that don't lead the student to study too much extraneous information (less unnecessary details)/scaffolded study guides
- scaffolded notes
- teaching the main ideas/concepts (limiting not needed details) to be taught and repeating them in several different ways over several different days (goal is 7 different ways same concept for students with learning disabilities)

## **G&T Modifications:**

---

- Determine where students' interests lie and capitalize on their inquisitiveness. (Is there a specific career they are interested in? How would this apply to their interest?)
- Employ differentiated curriculum to keep interest high.
- Encourage students to explore concepts in depth and encourage independent studies or investigations.
- Invite students to explore different points of view on a topic of study and compare the two.
- Provide additional rigorous challenge problems for advanced students
- Student led/directed discussions

## **At Risk Modifications**

---

- guided notes
- hands-on Instruction
- modeling and showing lots of examples
- non-verbal redirection of behaviors
- outlines & graphic organizers
- scaffolded notes
- slower pacing of materials
- study guides

## **Alternative assessments:**

---

Alternative assessments:

Performance tasks

Project-based assignments

Problem-based assignments

Presentations

Reflective pieces

Concept maps

Case-based scenarios

Portfolios

## **Benchmark Assessments:**

---

Skills-based assessment

Reading response

Writing prompt

Lab practical

## **Formative Assessment:**

---

- Anticipatory Set
- Closure
- EM force quiz
- gravity quiz
- Nuclear forces quiz
- Warm-Up

## **Summative Assessment:**

---

- Alternate Assessment
- Forces unit test
- Marking Period Assessment
- Personalized assessment

## **Resources & Materials:**

---

- Lab equipment
- Notes
- practice
- study guides

## **Technology:**

---

- Analyze the capabilities and limitations of current and emerging technology resources and assess their potential to address personal, social, lifelong learning, and career needs. 8.1.12.D.5
- Apply previous content knowledge by creating and piloting a digital learning game or tutorial. 8.1.12.B.2

- chromebook
- Develop an innovative solution to a real world problem or issue in collaboration with peers and experts, and present ideas for feedback through social media or in an online community. 8.1.12.C.1
- <https://phet.colorado.edu/en/simulation/gravity-force-lab>
- <https://phet.colorado.edu/en/simulation/legacy/gravity-and-orbits>
- [https://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom\\_en.html](https://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html)
- <https://sites.google.com/site/mantonphysicalscience/>
- Internet
- Research and evaluate the impact on society of the unethical use of digital tools and present your research to peers. 8.1.12.E.2

|                   |  |
|-------------------|--|
| TECH.8.1.12.A.2   | Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review. |
| TECH.8.1.12.A.5   | Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.                                 |
| TECH.8.1.12.A.CS2 | Select and use applications effectively and productively.  |
| TECH.8.1.12.B.CS1 | Apply existing knowledge to generate new ideas, products, or processes.  |
| TECH.8.1.12.B.CS2 | Create original works as a means of personal or group expression.  |
| TECH.8.1.12.C.CS1 | Interact, collaborate, and publish with peers, experts, or others by employing a variety of digital environments and media.  |
| TECH.8.1.12.C.CS2 | Communicate information and ideas to multiple audiences using a variety of media and formats.  |
| TECH.8.1.12.C.CS4 | Contribute to project teams to produce original works or solve problems.   |
| TECH.8.1.12.D.1   | Demonstrate appropriate application of copyright, fair use and/or Creative Commons to an original work.  |
| TECH.8.1.12.D.CS1 | Advocate and practice safe, legal, and responsible use of information and technology.  |
| TECH.8.1.12.D.CS2 | Demonstrate personal responsibility for lifelong learning.   |
| TECH.8.1.12.F.CS1 | Identify and define authentic problems and significant questions for investigation.  |
| TECH.8.1.12.F.CS3 | Collect and analyze data to identify solutions and/or make informed decisions.   |