Unit 5: Electrostatic and Nuclear Forces

Content Area: **Science**
Course(s):
Time Period: **Marking Period 3**
Length: **4 Weeks**
Status: **Published**

Summary

In this unit, students will build off of their knowledge of chemistry from the previous school year to analyze electrostatic forces and relate them to their every day experiences. Coulomb's Law is introduced and used to calculate the force between charged particles. The relationship between moving electric charges and magnetic fields is briefly discussed. Strong nuclear and weak nuclear forces are introduced qualitatively, and the role they play in nuclear fusion is discussed.

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1	Make sense of problems and persevere in solving them
L.SS.11–12.1.A	Apply the understanding that usage is a matter of convention, can change over time, and place, and is sometimes contested.
9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
2	Reason abstractly and quantitatively
3	Construct viable arguments and critique the reasoning of others
9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
4	Model with mathematics
L.KL.11–12.2.A	Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level.
PS1.A	Structure and Properties of Matter
	Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.
5	Use appropriate tools strategically
9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
6	Attend to precision
	Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
L.VL.11–12.3.D	Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.
	Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.
	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.
8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.
	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.
PS1.A	Structure and Properties of Matter
	The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
PS2.B	Types of Interactions
	Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
W.AW.11–12.1.A	Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.
	Developing and Using Models
W.AW.11–12.1.D	Establish and maintain a style and tone appropriate to the audience and purpose (e.g., formal and objective for academic writing) while attending to the norms and conventions of the discipline in which they are writing.
W.AW.11–12.1.E	Provide a concluding paragraph or section that supports the argument presented (e.g., articulating implications or the significance of the topic).
	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.
W.IW.11–12.2	Write informative/explanatory texts (including the narration of historical events, scientific procedures/experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
	Develop a model based on evidence to illustrate the relationships between systems or between components of a system.
	Energy and Matter
	Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
9.4.12.TL.3	Analyze the effectiveness of the process and quality of collaborative environments.
SL.PE.11–12.1.B	Collaborate with peers to promote civil, democratic discussions and decision-making, set clear goals and assessments (e.g., student developed rubrics), and establish individual roles as needed.
8.2.12.EC.2	Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.
8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
8.2.12.ETW.4	Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints.

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. Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields. Assessment is limited to systems with two objects. Using Mathematics and Computational Thinking Mathematical and computational thinking at the 9–12 builds on K–8 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 representations of phenomena to describe explanations.
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. 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. Patterns Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
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. Assessment is limited to designing and conducting investigations with provided materials and tools.
PS2.B	Types of Interactions 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.
PS3.A	Definitions of Energy "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.

Essential Questions/Enduring Understanding

Essential Questions

How do objects interact across large distances without contact?

How do electrostatic interactions help us understand some forms of energy and different types of forces on a microscopic scale?

How can an understanding of electrostatics help keep people safe?

Enduring Ubderstandings

Mathematical models, such as Coulomb's Law and Newton's Law of Universal Gravitation, help us see similarities between seemingly disparate physics phenomena.

Objectives

Students will know the difference between a good conductor and a good insulator.
Students will know two ways electric charges can be transferred.
Students will know what happens when a charged object is placed near a conductor or an insulator.
Students will be skilled at calculating the force between charged particles using Coulomb's Law.
Students will know the differences and similarities between Coulomb's Law and The Law of Universal Gravitation.
Students will be skilled at drawing electric and magnetic fields.
Students will know the role strong and weak nuclear forces play in nuclear fusion.
Students will know the life cycle of a star and explain how nuclear fusion powers a star.

Learning Plan

Students will conduct numerous observational experiments and testing experiments to probe the nature of electrostatic and magnetic forces. Hands-on equipment and small group work will be used extensively.

The PhET simulation Balloons and Static Electricity and/or John Travoltage will help students visualize the transfer of electrons during static electricity phenomena.

Real data will be provided for students to analyze in order to come up with the basic form of Coulomb's Law.

The experimental discovery of Coulomb's constant will be discussed and replicated using a PhET simulation. Students will review scientific notation and apply it to problem solving using Coulomb's Law.

Electric fields will be discussed and compared to magnetic fields and gravitational fields. Magnetic fields will be visualized in class using magnets, compasses, and iron filings. Students will use electroscopes to conduct experiments.

Students will investigate practical applications of electric field knowledge, such as what to do in a lightning storm or how spiders "fly".

If equipment permits, students will make predictions of what will happen to various objects (including themselves) near the Van de Graaff generator and test those predictions with an in-class demonstration day.

Assessment

Formative: Students will draw many charge diagrams that are assessed during class through whiteboard presentations. Solutions to Coulomb's Law problems will be completed both in groups and independently for

teacher feedback. Students will complete independent homework assignments that will be reviewed in class so that they can self-assess.

Summative: Quizzes on Electrostatic and Nuclear Forces, Unit Text, Coulomb's constant lab, magnetic field lab.

Benchmark: This unit is included in the final exam.

Alternative: Presentation/Project on Magnetic Field

Materials

Computer with PowerPoint/Google Slides and internet access

Textbook Physics: Principles and Problems, Glencoe

Calculators, rulers, meter sticks, colored pencils, graph paper, Chromebooks for students, whiteboards for collaborative work, dry erase markers and erasers for student groups, electrostatics rods and fabrics, magnets, iron filings, compasses, food coloring, alcohol prep pads, paper, plastic cups, access to water, Van de Graaff generator and accessories, electroscopes, Cosmos: A Spacetime Odyssey series (hard copy or EdPuzzle).

Integrated Accommodations and Modifications

Integrated Accommodation and Modifications, Special Education students, English Language Learners, At-Risk students, Gifted and Talented students, Career Education, and those with 504s

https://docs.google.com/spreadsheets/d/18XhAi7Rm-E8LJwO4uMQS7ZEh0dh3NxYbTFH2IoHLH7Y/edit?usp=sharing