Lindenwold Public Schools

Unit 1 - Why Don't We Fall Through the Floor?

45 instructional days

New Jersey Student Learning Standards Science

HS-PS1-1: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.]

HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. [Clarification Statement: 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.] [Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.]

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. [Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.] [Assessment Boundary: Assessment is limited to systems with two objects.]

HS-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* [Clarification Statement: 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.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.]

HS-PS3-2: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects). [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an

object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.]

HS-PS3-5: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.] [Assessment Boundary: Assessment is limited to systems containing two objects.]

Science and Engineering Practices

Developing and Using Models

- Use a model to predict the relationships between systems or between components of a system (HS-PS1-1).
- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2, HS-PS3-5)

Planning and Carrying Out Investigations

- 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. (HS-PS1-3)

Using Mathematics and Computational Thinking

- Use mathematical representations of phenomena to describe explanations. (HS-PS2-4)

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- Theories and laws provide explanations in science. (HS-PS2-4)
- Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-4)

Obtaining, Evaluation, and Communicating Information

- Communicate scientific and technical information (e.g., about the process of development and the design and performance of a proposed process or system) in multiple formats (including oral, graphical, textual and mathematical). (HS-PS2-6)

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Disciplinary Core Ideas

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. (HS-PS1-1)
- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1)
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3)

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)
- 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. (HS-PS2-6)

PS3.A: Definitions of Energy

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. There is a single quantity called energy due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-2)
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2)
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)

PS3.C: Relationship Between Energy and Forces

- When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)

Crosscutting Concepts

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-PS1-1, HS-PS1-3, HS-PS2-4)

Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)

Energy and Matter

- Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2)

Cause and Effect

- Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS3-5)

Rationale and Transfer Goals :

The purpose of this unit is to have students gain an understanding of how microscopic particles can have an effect on macroscopic objects. Students will review atoms and their structure in order to gain an understanding of how field forces are created. Students will then gain an understanding of how the strength of a field force is determined by the mass (gravitational field) or the amount of charge (electrostatic field) and how far away from the source of the field an object is. Students will then be able to apply what they learned about atomic composition dn field forces to answer the main idea of why we don't fall through the floor.

Enduring Understandings:

- All matter is made up of atoms.
- Atoms have a positively charged nucleus and are surrounded by negatively charged electrons.
- Gravitation is the result of the attraction between all mass/matter.

- An electric force is a universal force that exists between any two charged objects.
- All charged objects have electric fields.
- As distance increases, the strength of a field will exponentially decrease.

Essential Questions:

- Why are people on Earth stuck here while astronauts appear to be weightless? [Phenomena]
- How does the weight (force of gravity) of an astronaut of a specific mass change at specific distances from Earth as the shuttle moves away from the Earth? [Phenomena]
- How can an object exert a force on another object without touching it? [Phenomena]
- Why do you get shocked when you get out of your car in the winter? [Phenomena]

Content/Objectives		Instructional Actions	
Content ***What students will know***	**Skills** ***What students will be able to do***	**Activities/Strategies** ***How we teach content and skills***	**Evidence (Assessments)** ***How we know students have learned***
• A positively-charged nucleus is composed of both protons and neutrons, surrounded by negatively-charged electrons. • The difference in the number of protons and electrons in an atom will determine the electric charge of an atom. • The strength of a force decreases as you move	• Use the periodic table to predict patterns of behavior of the elements based on the attraction and repulsion between electrically charged particles and the patterns of outermost electrons that determine the typical reactivity of an atom. • Describe why the data about bulk properties	• Create an activity based around an interactive periodic table [link] that will allow students to determine how two atoms will interact with one another due to their respective electric fields. • Using the PhET simulation [link], show how an imbalance of protons and electrons will cause a net charge and how these net	• Students will be able to determine whether any two atoms in close proximity to each other will attract and repel. • Students will be able to answer a question that explains the transfer of electrons between two objects and explain the net charge on each object after the transfer.

further away from the source of a field. ● The molecular level structure of a material is important in the effect on a macroscopic object. ● Changes in the relative position of objects in a field can affect the energy of the field.	would provide information about strength of the electrical forces between the particles of the chosen substance. ● Correctly use the given mathematical formulas to predict the gravitational force between objects or predict the electrostatic force between charged objects. ● Identify and communicate the evidence for why molecular level structure is important in how the structure and properties of matter determine the function of a material. ● Develop a model in which they identify and describe the relevant components to illustrate the forces and changes in energy involved when two objects interact.	charges react to other objects with a net charge. ● Calculate the strength of the gravitational force based on parameters given such as in this PhET simulation [link]. ● Using a simulation such as this one from PhET [link] students describe how outer-level electrons can cause two solid objects to not pass through one another. ● Using this PhET simulation [link], understand what is meant by the term voltage and how it describes a change in energy based on the location to the source of a field.	● Students will be able to use Newton's LAw of Gravitation equation and Coulomb's Law equation to solve for unknown variables within the equations. ● Students will be able to answer the unit question, why don't we fall through the floor? ● Students will be able to explain what happens to the energy of an object as it moves closer to or further from the source of a field correctly. ● Physics Unit 1 Benchmark

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Spiraling for Mastery		
Content or Skill for this Unit	**Spiral Focus from Previous Unit**	**Instructional Activity**
• Each pure substance has characteristic physical and chemical properties that can be used to identify it. • The total number of each type of atom is conserved, and thus the mass does not change. • For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction. • Electric and magnetic forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. • A system of objects may also contain stored energy, depending on their relative positions. • When two objects interact, each one exerts a force on the other that can	• Develop models to describe the atomic composition of simple molecules and extended structures. • Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. • Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. • 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. • Develop a model to describe that when the arrangement of objects interacting at a distance changes, different	• Review of the structure of the atom and the properties of the atom. • Review of Newton's Laws of Motion. • Review of the types of reactions that can occur between electric charges and magnetic poles. • A review of kinetic and potential energy and what they represent. • A review of the gravitational force and its purpose within the solar system.

cause energy to be transferred to or from the object. ● The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.	amounts of potential energy are stored in the system. ● 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. ● Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.	

Key resources:

- OpenSTAX College Physics [Link]
- WebAssign Homework [Link]
- PhET Simulations [Link]
- oPhysics [Link]
- Physlet [Link]

21st Century Life & Careers:

9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.

9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.

9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

Career Readiness, Life Literacies, & Key Skills:

9.4.12.CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).

9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.

9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others.

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.

9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately.

9.4.12.IML.6: Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity.

InterDisciplinary Connections/Companion Standards:

NJSLS Math

HSN-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. (HS-PS1-3, HS-PS2-4, HS-PS2-6)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-4, HS-PS2-6)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-3)

NJSLS ELA

RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. (HS-PS1-1)

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3, HS-PS2-6)

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-3, HS-PS3-5)

WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3, HS-PS3-5)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3, HS-PS3-5)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS2-6)

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS3-2, HS-PS3-5)

Companion Standards for ELA in Science and Technical Subjects: Reading

Key Ideas and Details

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.

Integration of Knowledge and Ideas

RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

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.

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.

Companion Standards for ELA in Science and Technical Subjects: Writing

Research to Build and Present Knowledge

WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating an understanding of the subject under investigation.

WHST.11-12.9. Draw evidence from informational texts to support analysis, reflection, and research.