PUBLIC SCHOOLS OF EDISON TOWNSHIP

OFFICE OF CURRICULUM AND INSTRUCTION

Physics 1-2

Length of Course:	Term
Elective/Required:	Elective
Schools:	High Schools
Eligibility:	Grades 11, 12
Credit Value:	5 Credits
Date Approved:	September 24, 2018

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Statement of Purpose

Introduction

Physics is a study that encompasses all that humans understand about the nature of the universe, but also provides a rigorous discussion of the unknown. This makes it an ideal subject to provide the inquiry based learning that promotes curiosity and progress.

The focus of the Physics 1-2 course is to develop and nurture the skills necessary to problem solve, design experiments, analyze assumptions, and evaluate the validity of scientific claims. The final goal is to combine these skills to provide students with a strong ability to collaborate with each other in determining and solving societal issues, such as energy production/usage.

These skills will be developed while discovering the physical laws and theories that are involved in describing motion, forces, energy, wave and electrical phenomena; providing students with a better understanding of the universe and how it works.

This curriculum guide was compiled in the year 2016 and updated in 2018 and is designed to accompany existing course materials. This curriculum guide was revised/updated by:

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Course Objectives

The student will be able to:

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.

HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

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.

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.

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.

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 motions of particles (objects) and energy associated with the relative positions of particles (objects).

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.

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.

HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

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.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for commercial or professional audience and present it to peers and/or professionals in that related area for review.

Career Ready Practices

CRP4. Communicate clearly and effectively with reason

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them

CRP11. Use technology to enhance productivity

Pacing Timeline

First Quarter Topics	Second Quarter Topics	Third Quarter Topics	Fourth Quarter Topics
• Systems and Mass • Forces and Acceleration • Momentum and Inertia • Momentum conservation versus constant momentum • Impulse and changes in momentum • Newton's Laws of Motion • Common types of forces • Gravitational forces and free fall • Surface interactions: Frictional forces, normal forces, coefficient of frictional force	• Mechanical work transfers energy into a system • Work is dependent on force and displacement • Conservation of energy versus constant energy • Common types of mechanical energy • Energy Transfer versus Energy Conversion • Power is the time rate of work done or energy transferred	• Uniform circular motion • Centripetal Acceleration is dependent on the tangential speed of the system and radius of the circle • Wave behavior and properties	• Charges, Electric force, and Electric Field • Electric Potential Energy, Electric Potential, and Electric Potential Difference (Voltage) • Resistors and Resistivity • Batteries • Series and Parallel Circuits • Magnetism

Unit 1: Momentum and Force

Essential Questions
Why are cars designed to crumple? Why do some objects bounce more than others? How does motion change?

NGSS/NJSLS Performance Expectations
Students who demonstrate understanding can:

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.

HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

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.

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

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.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Unit Assessment
What is the authentic evidence that students have achieved the targeted standards/unit objective?
Analyze a collision between two objects or vehicles then predict and design a method to reduce damage to either the objects or the occupants of the vehicles.

Unit 1: Momentum and Force (Con't)

Student Learning Objectives			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies** *Technology Implementation/ Interdisciplinary Connections*	**Assessments** *Formative, Summative and Performance Based*
PS2.A: Forces and Motion Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS21) Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-2) If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3) **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	**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-PS2-3) **Analyzing and Interpreting 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. (HS-PS21) **Using Mathematics and Computational Thinking** Use mathematical representations of phenomena to describe explanations. (HS-PS2-2),(HS- PS2-4)	**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-PS2-4) **Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1) Systems can be designed to cause a desired effect. (HSPS2-3) **Systems and System Models** When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2)	Constant motion experiment Accelerated motion experiment Collisions experiment Free fall experiment Virtual & video experiments Discovery Education Techbook For Edison BOE Units: Forces, Motion, Conservation of Energy and Momentum Creating models of motion using verbal, pictorial, physical, and mathematical models with computation technology tools. Individual/Group problem solving with the textbook, practice problems, problems involving interdisciplinary connections, and self created problems to be shared.	Formative Assessments: Diagnostic pre- and post assessments, class discussions, worksheets with teacher feedback, drafts of lab reports with teacher feedback Summative Assessments: Quizzes, tests, performance assessments/laboratory investigations, research/lab reports **Assessment Boundaries:** • Assessment is limited to one dimensional motion and to macroscopic objects moving at non-relativistic speeds. • Assessment is limited to systems of two macroscopic bodies moving in one dimension.

Unit 1: Momentum and Force (Con't)

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. (HSPS2-4) **ETS1.A: Defining and Delimiting an Engineering Problem** Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2-3) **ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) Both physical models and computers can be used in various ways to aid in the	**Constructing Explanations and Designing Solutions** Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3) **Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** Theories and laws provide explanations in science. (HS-PS21),(HS-PS2-4) Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1),(HS-PS2-4		**Clarification Statements:** ● Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force. ● Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle. ● Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute. ● Emphasis is on both quantitative and	● Assessment is limited to qualitative evaluations and/or algebraic manipulations. ● Assessment is limited to systems with two objects.

Unit 1: Momentum and Force (Con't)

engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) **ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS2-3)			conceptual descriptions of gravitational and electric fields.	

Resources: *Essential Materials, Supplementary Materials, Links to Best Practices* Discovery Education Science Techbook For Edison BOE *Conceptual Physics: The High School Physics Program* Custom Edition By Paul G. Hewitt Copyright © 2012 by Pearson Education, Inc. ISBN 10: 1-256-76380-2 ISBN 13: 978-1-256-76380-2 Access to internet, Java, and HTML5 capable computing devices for simulations, data collection, and analysis. Experimental equipment pertinent to lab activities.	**Instructional Adjustments:** *Modifications, student difficulties, possible misunderstandings* ● Group collaboration ● Multiple representations – verbal, pictorial, physical models, graphical, and mathematical ● Computer simulations and direct measurement videos ● Online documents provided with structured activities, practice problems and key points

Unit 2: Mechanical Energy and Power

Essential Questions
How are humans dependent upon transformations of energy? If you hold an object while you walk at a constant velocity, are you doing work on the object? Why or why not? What factors affect the collision of two objects, and how can you determine whether the collision is elastic or inelastic? How is the energy of a system defined? How is work represented graphically? What is mechanical energy and what factors affect its conservation?

NGSS/NJSLS Performance Expectations
Students who demonstrate understanding can:

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.

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 motions of particles (objects) and energy associated with the relative positions of particles (objects).

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.

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

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.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Unit Assessment
What is the authentic evidence that students have achieved the targeted standards/unit objectives?

Create a device that harnesses and utilizes energy conservation.

Unit 2: Mechanical Energy and Power (Con't)

Student Learning Objectives			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies** *Technology Implementation/ Interdisciplinary Connections*	**Assessments** *Formative, Summative and Performance Based*
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. That there is a single quantity called energy is 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-PS3-1),(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) (HS-PS3-3) 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	**Developing and Using Models** Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2) **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-PS33) **Using Mathematics and Computational Thinking** Create a computational model or simulation of a	**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-PS3-3) **Systems and System Models** When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HSPS3-3) Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1)	Breaking objects or 'destructiveness' experiment Roll on ramp experiment Multi-track ramp experiment Virtual and video experiments Discovery Education Techbook For Edison BOE Unites: Conservation of Energy and Momentum Creating models of energy using verbal, pictorial, physical, and mathematical models Use a variety of everyday situations to develop an understanding of the concepts of work and energy including the importance of direction while finding work done. Develop terminology based on everyday situations to describe different types of energy	Formative Assessments: Diagnostic pre- and post assessments, class discussions, worksheets with teacher feedback, drafts of lab reports with teacher feedback Summative Assessments: Quizzes, tests, performance assessments/laboratory investigations, research/lab reports **Assessment Boundaries:** ● Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational,

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.B: Conservation of Energy and Energy Transfer** Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HSPS3-1) Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) The availability of energy limits what can occur in any system. (HS-PS3-1)	phenomenon, designed device, process, or system. (HS-PS3-1) **Constructing Explanations and Designing Solutions** Design, evaluate, and/or refine a solution to a complex real world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS3-3)	**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. (HSPS3-3) Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2) **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)	Use a variety of methods to represent Work/Energy and the concept of conservation (verbal, pictorial, graphical, mathematical) Conservation of Energy – provide examples of situations where energy is conserved, but due to assumptions it does not remain constant for the system. Create an analogy for this. Students to create and perform an experiment in which they create the physical quantity of power then determine the power of a system. Elastic and inelastic collisions experiment Individual/Group problem solving with the textbook, practice problems, problems involving interdisciplinary connections, and self created problems to be shared. **Clarification Statements:** • Emphasis is on explaining the meaning of mathematical expressions used in the model. 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	magnetic, or electric fields. • Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.

			include diagrams, drawings, descriptions, and computer simulations. Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators.	

Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4) **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) **PS3.D: Energy in Chemical Processes** Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3) **ETS1.A: Defining and Delimiting an Engineering Problem** Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS3-3)				

Resources: *Essential Materials, Supplementary Materials, est Practices* *Links to* Discovery Education Science Techbook For Edison BOE *Conceptual Physics: The High School Physics Program* Custom Edition By Paul G. Hewitt Copyright © 2012 by Pearson Education, Inc. ISBN 10: 1-256-76380-2 ISBN 13: 978-1-256-76380-2 s for simulations, data Access to internet, Java, and HTML5 capable computing device collection, and analysis. Experimental equipment pertinent to lab activities.	

Unit 3: Oscillations and Waves

Essential Questions
How are velocity, frequency, and wavelength used to describe a wave? What factors affect how a wave is reflected? How is it possible for two waves to occupy the same space at the same time? What conditions are necessary to form a standing wave? How does a television signal get from the station to a television?

NGSS/NJSLS Performance Expectations
Students who demonstrate understanding can:

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Unit Assessment
What is the authentic evidence that students have achieved the targeted standards/unit objectives?

Determine how our communication infrastructure works by developing a mechanical wave communication device.

Student Learning Objectives			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies** *Technology Implementation/ Interdisciplinary Connections*	**Assessments** *Formative, Summative and Performance Based*
ESS1.B: Earth and the Solar System Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.	**Using Mathematics and Computational Thinking** Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS4-1)	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-1) Cause and effect relationships can be	Circular motion experiment Orbits simulation analysis Creating models of oscillations and waves using verbal, pictorial, physical, and mathematical models	Formative Assessments: Diagnostic pre- and post assessments, class discussions, worksheets with teacher feedback, drafts of lab reports with teacher feedback

(HS-ESS1-4) **PS4.A: Wave Properties** The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1)		suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS4-1) Systems can be designed to cause a desired effect. (HSPS4-1) **Systems and System Models** Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-PS4-1) Stability and Change Systems can be designed for greater or lesser stability. (HS-PS4-1)	Discovering waves with waves on a slinky and in a wave pool. Sound waves and beats experiment. Physics of music project Doppler effect experiments Virtual and video experiments Discovery Education Techbook For Edison BOE Units: Waves Individual/Group problem solving with the textbook, practice problems, problems involving interdisciplinary connections, and self created problems to be shared. **Clarification Statements:** ● Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons. ● Examples of data could include	Summative Assessments: Quizzes, tests, performance assessments/laboratory investigations, research/lab reports **Assessment Boundaries:** ● Assessment is limited to algebraic relationships and describing those relationships qualitatively. ● Mathematical representations for the gravitational attraction of bodies and Kepler's Laws of orbital motions should not deal with more than two bodies, nor involve calculus. ● Assessments are limited to qualitative information. Assessments do not include band theory.

			electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth. ● Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.	

Resources: *Essential Materials, Supplementary Materials, Links to B* *est Practices* Discovery Education Science Techbook For Edison BOE *Conceptual Physics: The High School Physics Program* Custom Edition By Paul G. Hewitt Copyright © 2012 by Pearson Education, Inc. ISBN 10: 1-256-76380-2 ISBN 13: 978-1-256-76380-2 s for simulations, data Access to internet, Java, and HTML5 capable computing device collection, and analysis. Experimental equipment pertinent to lab activities.	**Instructional Adjustments:** *Modifications, student difficulties, possible misunderstandings* ● Group collaboration ● Multiple representations – verbal, pictorial, physical models, graphical, and mathematical ● Computer simulations and direct measurement videos ● Online documents provided with structured activities, practice problems and key points

Unit 4: Electricity and Magnetism

Essential Questions
What is the cause of static electricity? How are electric forces similar to gravitational forces? How does an electric circuit demonstrate conservation of charge? What factors affect the resistance of a wire? How can a device charge without a plug?

NGSSNJSLS Performance Expectations
Students who demonstrate understanding can:

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.

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.

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.

Unit Assessment
What is the authentic evidence that students have achieved the targeted standards/unit objectives?

Understand why our electrical infrastructure is designed the way it is by designing a wiring schematic for a building.

Student Learning Objectives			**Instructional Actions**	
Disciplinary Core Ideas	**Science and Engineering Practices**	**Crosscutting Concepts**	**Activities/Strategies** *Technology Implementation/ Interdisciplinary Connections*	**Assessments** *Formative, Summative and Performance Based*
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)	**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,	**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-PS2-4)	Coulomb's law and electric potential energy experiments with electrostatic rods, conductors, and simulations. Create electric fields and electric potential with diagrams, derivations, and	Formative Assessments: Diagnostic pre- and post assessments, class discussions, worksheets with teacher feedback, drafts of lab reports with teacher feedback

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-PS25) **PS3.A: Definitions of 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-PS2-4) Cause and Effect Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HSPS2-1),(HS-PS2-5) Systems can be designed to cause a desired effect. (HS-PS2-3) **Systems and System Models** When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2) **Energy** "Electrical energy" may mean energy stored in a battery or	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-PS2-5) **Analyzing and Interpreting 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. (HS-PS2-1) **Using Mathematics and Computational Thinking** Use mathematical representations of phenomena to describe explanations. (HS-PS2-2),(HS-PS2-4) **Constructing Explanations and Designing Solutions** Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HSPS2-3)	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1),(HSPS2-5 Systems can be designed to cause a desired effect. (HSPS2-3) **Systems and System Models** When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2)	analogies activity. Ohm's law experiment using batteries, wires, resistors, and simulations. Series and parallel circuit configuration experiments with circuit kits and simulations. Resistors and resistance experiment with various materials, a voltage source, and simulations. Magnetism experiment with moving charges, magnets, a coil, ammeter, and simulations. Virtual and video experiments Discovery Education Techbook For Edison BOE Units: Electromagnetism Individual/Group problem solving with the textbook, practice problems, problems involving interdisciplinary connections, and self created problems to be shared. **Clarification Statements:** ● Emphasis is on both quantitative	Summative Assessments: Quizzes, tests, performance assessments/laboratory investigations, research/lab reports **Assessment Boundaries:** ● Assessment is limited to systems with two objects. ● Assessment is limited to designing and conducting investigations with provided materials and tools. ● Assessment is limited to systems containing two objects.

Unit 4: Electricity and Magnetism (cont.)

energy transmitted by electric currents. (secondary to HS-PS2-5) **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) **ETS1.A: Defining and Delimiting an Engineering Problem** Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2-3) **ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS2-3)	**Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** Theories and laws provide explanations in science. (HSPS2-1),(HS-PS2-4) Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1),(HS-PS2-4)		• and conceptual descriptions of gravitational and electric fields. 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	

Unit 4: Electricity and Magnetism (cont.)

Resources: *Essential Materials, Supplementary Materials, Links to Best Practices*	**Instructional Adjustments:** *Modifications, student difficulties, possible misunderstandings*
Discovery Education Science Techbook For Edison BOE *Conceptual Physics: The High School Physics Program* Custom Edition By Paul G. Hewitt Copyright © 2012 by Pearson Education, Inc. ISBN 10: 1-256-76380-2 ISBN 13: 978-1-256-76380-2 Access to internet, Java, and HTML5 capable computing devices for simulations, data collection, and analysis. Experimental equipment pertinent to lab activities.	• Group collaboration • Multiple representations – verbal, pictorial, physical models, graphical, and mathematical • Computer simulations and direct measurement videos • Online documents provided with structured activities, practice problems and key points