

	Physics https://www.doe.mass.edu/frameworks/scitech/2016-04.pdf Syllabus	
	Unit ONE: Kinematics in one dimension	
Essential Questions	How do you verbally describe the motion of an object? How can the motion of an object be represented on a graph? How can the motion of an object be represented algebraically?	
Science Standards	HS-PS2-10(MA). Use free-body force diagrams, algebraic expressions, and Newton's laws of motion to predict changes to velocity and acceleration for an object moving in one dimension in various situations.	
Concepts and skills	- Distance, Displacement - Speed, Velocity - Acceleration - Graphical representation of motion - Use of equations of constant acceleration - Connection between vocabulary, graphs, equations.	Science and Engineering practices S1. Asking questions (for science) and defining problems (for engineering). S2. Developing and using models. S3. Planning and carrying out investigations. S4. Analyzing and interpreting data. S5. Using mathematics and computational thinking. S6. Constructing explanations (for science) and designing solutions (for engineering). S7. Engaging in argument from evidence. S8. Obtaining, evaluating, and communicating information Common Core Reading Standards TBD Common Core Math Standards TBD
Content Objectives "I can Statements"	Given a motion, I can analyze the distance traveled and the displacement change Given language of motion, I can interpret the corresponding position, velocity, and acceleration graphs Given a graph, I can communicate the motion of the object Given a graph, I can calculate appropriate numerical information of motion Given a graph, I can construct other graphs explaining its motion Given a description of motion, I can make computational predictions Given the motion of two objects moving simultaneously somehow, I can solve for appropriate numerical information through the use of quadratic equation. *evidence of why the graph shows the motion	

Assessments, products, practice	Kinematics Test (Validated) , Equations Quiz, Graphs Quiz, Graphing Lab, Motion Lab, Equations assignments, Graphs assignments
Text, Materials, and Resources	Worksheets, lab documents, motion lab equipment, PASCO CAPSTONE, physical objects, internet, lecture notes

	UNIT TWO: Projectile Motion	
Essential Questions	At what rate do objects fall to the ground? How does an object's vertical motion influence its horizontal motion? How does an object's horizontal motion influence its vertical motion? Why do objects follow parabolic paths when they are in free fall? What can we use the one dimensional kinematics equations to describe the two dimensional motion of a projectile? H: If more than one projectile moves simultaneously, how is it that neither object accelerates?	
Science Standards	HS-PS2-10(MA). Use free-body force diagrams, algebraic expressions, and Newton's laws of motion to predict changes to velocity and acceleration for an object moving in one dimension in various situations.	
Concepts and skills	- Graphical representation of 2D motion - Use of equations of constant acceleration in two dimensions - Connection between vocabulary, graphs, equations. - Separation of coordinate dimensions	Science and Engineering practices S1. Asking questions (for science) and defining problems (for engineering). S2. Developing and using models. S3. Planning and carrying out investigations. S4. Analyzing and interpreting data. S5. Using mathematics and computational thinking. S6. Constructing explanations (for science) and designing solutions (for engineering). S7. Engaging in argument from evidence. S8. Obtaining, evaluating, and communicating information Common Core Reading Standards TBD Common Core Math Standards TBD
Content Objectives "I can"	I can identify parts of projectile motion where velocity is zero I can interpret a given two dimensional motion to find relevant non-explicit information I can Use mathematical equations to predict where an object will land I can determine the initial velocity of a projectile based on where it lands using mathematical formulas	

Statements"	I can demonstrate that vertical and horizontal information can be kept independent in mathematical modeling *evidence of why the graph shows the motion H: I can use relative motion, when appropriate, if more than one projectile is launched simultaneously. H: I can use relative motion, when appropriate, if the launch site can move relative to the ground.
Assessments, products, practice	Projectiles Test, Launcher Challenge Lab/Quiz, Free Fall Lab, Projectiles without angles problems, Projectiles with angles problems, Kinematics- Graphs.doc
Text, Materials, and Resources	Worksheets, lab documents, motion lab equipment, PASCO CAPSTONE, physical objects, internet, lecture notes

	Physics https://www.doe.mass.edu/frameworks/scitech/2016-04.pdf Syllabus	
	UNIT THREE: Newton's Laws (Target end date for this unit is prior to December Break)	
Essential Questions	Under what conditions do objects accelerate? What are different ways an object's motion can be described if it is not accelerating? When the net force acting on an object is zero, how does it move? How does the direction of the net force acting on an object compare to the direction of acceleration? What is the relationship of the force acting on each object when two objects interact? What is the relationship between force acting on an object, mass of the object, and the acceleration of the object? What does a force diagram show? How does the force diagram turn into an equation?	
Science Standards	HS-PS2-10(MA). Use free-body force diagrams, algebraic expressions, and Newton's laws of motion to predict changes to velocity and acceleration for an object moving in one dimension in various situations.	
Concepts and skills	Analyze a situation to identify force pairs	Science and Engineering practices S1. Asking questions (for science) and defining problems (for engineering).

	- Analyze data to show the relationship between force, mass, and acceleration, in different scenarios - Draw a force diagram from a description of a situation, for one or two objects - Analyze a force diagram to construct expanded $F=ma$ equations. - Separation of coordinate dimensions - Determine the different types of forces acting on an object based on its situation	S2. Developing and using models. S3. Planning and carrying out investigations. S4. Analyzing and interpreting data. S5. Using mathematics and computational thinking. S6. Constructing explanations (for science) and designing solutions (for engineering). S7. Engaging in argument from evidence. S8. Obtaining, evaluating, and communicating information Common Core Reading Standards TBD Common Core Math Standards TBD
Content Objectives "I can Statements"	I can recognize which parts of a system are interacting, and identify newton's third law pairs I can analyze lab data to show the relationship between force, mass, and acceleration, through construction of appropriate graphs. I can use a written description of a situation to identify the different forces acting on an object, and their directions I can turn a force diagram into multiple equations I can mathematically solve for different unknowns in the $F=ma$ expanded equations I can convert between coordinate dimensions in order to create expanded $F=ma$ equations (H)	
Assessments, products, practice	Newton's Laws Test, Newton's Law Lab (Validated) direct, newton's law lab indirect, newton's third law demonstration, newton's first lab lab, basic force problems, 1 dimensional multiple force problems, 2 dimensional force problems involving friction and its coefficient, force problems with an angle, multiple body force problems	
Text, Materials, and Resources	Worksheets, lab documents, motion lab equipment, PASCO CAPSTONE, physical objects, internet, lecture notes	

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	UNIT FOUR: Momentum and Energy * This unit can be divided in multiple ways with the teacher using individual discretion, based on the calendar, makeup of the class, and other relevant factors, with part of the unit being taught

	before mid-year exams, and the unit completed by February Break.	
Essential Questions	What are major similarities and differences between impulse and work? What are major similarities and differences between momentum and kinetic energy? Under what conditions is momentum conserved? Not conserved? What are the similarities and differences between four major types of collisions? What is energy? Under what conditions is mechanical energy conserved? Not conserved? What is the relationship between work done on a system and energy of the system?	
Science Standards	HS-PS2-2. Use mathematical representations to show that the total momentum of a system of interacting objects is conserved when there is no net force on the system. Clarification Statement: • Emphasis is on the qualitative meaning of the conservation of momentum and the quantitative understanding of the conservation of linear momentum in interactions involving elastic and inelastic collisions between two objects in one dimension. HS-PS2-3. Apply scientific principles of motion and momentum to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* Clarification Statement: • Both qualitative evaluations and algebraic manipulations may be used HS-PS3-1. Use algebraic expressions and the principle of energy conservation to calculate the change in energy of one component of a system when the change in energy of the other component(s) of the system, as well as the total energy of the system including any energy entering or leaving the system, is known. Identify any transformations from one form of energy to another, including thermal, kinetic, gravitational, magnetic, or electrical energy, in the system. Clarification Statement: • Systems should be limited to two or three components and to thermal energy; kinetic energy; or the energies in gravitational, magnetic, or electric fields	
Concepts and skills	• Use newton's laws and kinematics equations to mathematically prove the relationship between impulse and momentum • Use newton's laws and kinematics equations to mathematically prove the relationship between work and kinetic energy • Evaluate laboratory data to demonstrate the connection between time and momentum	Science and Engineering practices S1. Asking questions (for science) and defining problems (for engineering). S2. Developing and using models. S3. Planning and carrying out investigations. S4. Analyzing and interpreting data. S5. Using mathematics and computational thinking. S6. Constructing explanations (for science) and designing solutions (for engineering). S7. Engaging in argument from evidence. S8. Obtaining, evaluating, and communicating information

	• Evaluate laboratory data to demonstrate the connection between displacement and kinetic energy • Use laboratory data to explain why kinetic energy is conserved in elastic collisions, but not in other collisions • Use laboratory data to differentiate four types of collisions • Given a data set, communicate to others how you know what type of collision occurred • Use laboratory data to demonstrate that momentum is conserved in collisions • Interpret the effect of positive/negative work on the total energy of a system • Use laboratory data to demonstrate mechanical energy is conserved for a falling object in the absence of friction • Use laboratory data to demonstrate how the presence of friction removes mechanical energy from a system • Use algebraic and computational skills to solve momentum and energy problems	Common Core Reading Standards TBD Common Core Math Standards TBD
Content Objectives "I can Statements"	I can demonstrate using evidence what type of collision has occurred I can use qualitative information to explain why kinetic energy should, or should not, be conserved during a specific collision I can demonstrate using data the validity of the impulse momentum theorem I can demonstrate using data the validity of the work energy theorem I can argue using evidence whether a situation is one in which mechanical energy will be conserved, or not I can analyze mathematical situations using the principles of conservation of momentum I can analyze mathematical situations using the principles of conservation of energy I can analyze mathematically why a system gained or lost energy based on the work done to it by external forces I can design a laboratory situation in which the mechanical energy of an object will be conserved I can track the different forms of energy through a situation that is given to me and explain how it is being converted from one form to another at each step	

Assessments, products, practice	Impulse momentum lab, work energy lab, collisions lab, conservation of energy lab, impulse momentum problem set, work energy problem set, collisions problem set, conservation of energy problem set
Text, Materials, and Resources	Worksheets, lab documents, motion lab equipment, PASCO CAPSTONE, physical objects, internet, lecture notes

	UNIT FIVE: Fundamental Forces (Newton's Laws of Gravitation, and Coulomb's Law)	
Essential Questions	How are charges distributed on or within conductors and insulators? Static charges create Electric Fields and Voltages, what are they and how are they related? If multiple charges exist what kinds of E-fields and Voltages are established? If free charges are placed with this space how do they respond and how is energy exchanged? What conditions need to be established to generate a consistent flow of charge?	
Science Standards	HS-PS2-4. Use mathematical representations of Newton's law of gravitation and Coulomb's law to both qualitatively and quantitatively describe and predict the effects of gravitational and electrostatic forces between objects. . HS-PS3-5. Develop and use a model of magnetic or electric fields to illustrate the forces and changes in energy between two magnetically or electrically charged objects changing relative position in a magnetic or electric field, respectively. HS-PS3-2. Develop and use a model to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles and objects or energy stored in fields.	
Concepts and skills	- Recognizes that charge is a fundamental property of matter. - Understands the concept of charge conservation and that charge is quantized. - Recognizes how charge is distributed on insulators and conductors both inside and out when charged objects are brought near or touch them respectfully.	Science and Engineering practices S1. Asking questions (for science) and defining problems (for engineering). S2. Developing and using models. S3. Planning and carrying out investigations. S4. Analyzing and interpreting data. S5. Using mathematics and computational thinking. S6. Constructing explanations (for science) and designing solutions (for engineering). S7. Engaging in argument from evidence. S8. Obtaining, evaluating, and communicating information Common Core Reading Standards TBD

	• Understands the difference between insulators and conductors and the ease or lack of movement of electrons. • Understands the analogy of a “sea of electrons” for conductors. • Understands Coulomb's law and how it directly compares to the universal gravitational force. • Applies the concept of the absolute value of the charge in all electric force and field equations. • Can take any atom or ion and calculate both the gravitational and electrostatic forces between the orbiting electrons and nucleus AND compare the strength of these forces to understand how some matter is held together and other matter is kept apart. • Draws electric field diagrams from a variety of charged scenarios. • Qualitatively can distinguish the strength of Electric fields, values of potentials, shapes of objects, concentrations of charge, and charge distributions based on electric field diagrams. • Problem solves for the magnitude and direction of the net electric force and electric field from a combination of point charges and between charged parallel plates. • Understands that potentials are not energy but directly related to potential energy AND that potentials are the same as voltages. • Relates voltages to energy and understands the scalar nature of these quantities. • Applies the sign of the charge to the value of the voltage or the energy.	Common Core Math Standards TBD
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	• Problem solves for the total voltage and potential energy for combination of point charges and between charged parallel plates. • Applies the conservation of energy to a moving charge. • Problem solves for forces, fields, voltages, energies, accelerations, velocities, displacements, and time as charges move between charged parallel plates; either as linear motion or simulated projectile motion.	
Content Objectives "I can Statements"	I can draw charge distributions under several known but different conditions I can draw a mapping of electric field lines and equipotential surfaces for various charge distributions, I can demonstrate using data the validity of Coulomb's Law. I can argue whether a charge gains or loses energy and whether the field or an outside agent causes the change. I can analyze mathematical situations using the principles of conservation of energy I can analyze mathematically why a system gained or lost energy based on the work done to it by the field or other forces	
Assessments, products, practice	Static electricity Lab, Electric Field Lab	
Text, Materials, and Resources	Worksheets, lab documents, statics lab equipment, PASCO CAPSTONE, physical objects, internet, lecture notes	

	UNIT SIX: Circuits	
Essential Questions	What is current or resistance and how does one affect the other? What is a circuit and what are the elements needed for circuits? How are different circuits constructed and what effects result? How is energy and power distributed throughout a circuit?	

Science Standards	HS-PS2-4. Use mathematical representations of Newton's law of gravitation and Coulomb's law to both qualitatively and quantitatively describe and predict the effects of gravitational and electrostatic forces between objects. HS-PS2-9(MA). Evaluate simple series and parallel circuits to predict changes to voltage, current, or resistance when simple changes are made to a circuit. HS-PS3-5. Develop and use a model of magnetic or electric fields to illustrate the forces and changes in energy between two magnetically or electrically charged objects changing relative position in a magnetic or electric field, respectively. HS-PS3-2. Develop and use a model to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles and objects or energy stored in fields.	
Concepts and skills	• Understands the concepts of current, resistance and change in voltage at a molecular level. • Relates the concepts of current, resistance, and voltage through Ohm's Law. • Graphically analyze the relationship expressed by Ohm's law. • Draws correct schematic diagrams for circuits that include symbols for batteries, voltmeters, ammeters, resistors, capacitors, and switches. • Draws correct schematic diagrams of resistors/capacitors connected in series, parallel, and all kinds of complex combinations. • Problem solves for currents, voltages, and resistance for resistors connected in series, parallel, and all kinds of complex combinations. • Problem solves for charges, voltages, and capacitance for capacitors connected in series, parallel, and all kinds of complex combinations. • Can predict how circuits are connected based on analyzing how light bulbs respond in a circuit as one bulb is removed and reconnected one at a time.	Science and Engineering practices S1. Asking questions (for science) and defining problems (for engineering). S2. Developing and using models. S3. Planning and carrying out investigations. S4. Analyzing and interpreting data. S5. Using mathematics and computational thinking. S6. Constructing explanations (for science) and designing solutions (for engineering). S7. Engaging in argument from evidence. S8. Obtaining, evaluating, and communicating information Common Core Reading Standards TBD Common Core Math Standards TBD

	Recognizes all the various units and their equivalents in this unit.	
Content Objectives "I can Statements"	I can design and construct various different kinds of circuits with a power source, resistors, ammeters, and voltmeters. I can analyze the mathematical situation using the principle of Ohm's Law. I can analyze the power distribution throughout the circuit stating which bulbs will be brighter to dimmer. I can predict outcomes to changes of an existing circuit.	
Assessments, products, practice	Ohm's Law Lab (Validated) , Resistors in Series Lab, Resistors in Parallel Lab, Complex circuits lab	
Text, Materials, and Resources	Worksheets, lab documents, statics lab equipment, PASCO CAPSTONE, physical objects, internet, lecture notes	

	UNIT SEVEN: Waves sound and light	
Essential Questions	What language and mathematical equations can I use to describe waves? What phenomena can be modeled as waves? Why? What properties of sound relate to its wave nature? What properties of light relate to its wave nature?	
Science Standards		
Concepts and skills		Science and Engineering practices S1. Asking questions (for science) and defining problems (for engineering). S2. Developing and using models. S3. Planning and carrying out investigations. S4. Analyzing and interpreting data. S5. Using mathematics and computational thinking. S6. Constructing explanations (for science) and designing solutions (for engineering). S7. Engaging in argument from evidence. S8. Obtaining, evaluating, and communicating information

		Common Core Reading Standards TBD Common Core Math Standards TBD
Content Objectives "I can Statements"		
Assessments, products, practice		
Text, Materials, and Resources		

CP1 Physics

Notes on Sequencing and Scope

1. 1D Kinematics
2. Free Fall and 2D Kinematics
3. Newton's Laws- Complete by December Break
 - Horizontal Surface with an Applied Force at an angle is CP1, on a ramp is Honors.
4. Energy
5. Momentum
 - Units 4 and 5 can be broken up at teacher discretion based on the calendar, with the goal of completing both units, ideally by Feb Break but no later than the end of the first week after break.
6. Fundamental Forces (Newton's Law of Gravitation, and Coulomb's Law)
 - Subtopics include Gravitational and Electric Fields, Gravitational Potential Energy, Electric Potential Energy, Escape Velocity, and Kepler's Laws. This unit is approximately 3 weeks, so not all subtopics will always be taught.
7. Circuits (Including 1 resistor, 2 resistor series and parallel, and compound Circuits)
 - Both Equivalent Resistance, and Khirchoff's Rules, should be taught, and equivalence shown as a method of problem solving.

8. Waves (General Waves, Sound, and Light)

- Subtopics include resonance, doppler effect, decibel levels, reflection, refraction, mirrors, curved mirrors, lenses, types of EM radiation, Photoelectric Effect, Quantum nature of light. These topics can be chosen at teacher discretion.