Passaic County Technical Institute

Wayne, NJ

Physics Honors 1 Curriculum

August 2015

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I. Course Description

Physics Honors 1 is a college level, algebra based general physics course somewhat similar to a introductory level university physics course. It is intended to be a second course taken after a first course in physics or general science. Students taking this course should have also taken and mastered the algebra 2 course. Some trigonometry is required and the necessary topics will be covered in a short the math methods review which will be an integral part of this advanced high school physics course.

The course covers five general areas in physics. They are Newtonian mechanics, Circular motion and Gravitation, Energy and Momentum, Vibrations and Waves and Introduction to Electricity.
This course has been approved for a maximum of four (4) college credits through Seton Hall University's Project Acceleration Program. The breakdown is as follows:

General Physics I	PHYS 1701-PPC	3 Credits
Physics Lab I	PHYS 1811- PPC	1 Credit

II. Course Objectives/Outline

<table>
<tr><td>Content Area:</td><td colspan="2">Physics</td><td>Grade(s)</td><td>10, 11, 12</td></tr>
<tr><td>Unit Plan1 Title:</td><td>Forces and Motion</td><td>Time Frame</td><td colspan="2">9 Weeks</td></tr>
<tr><td colspan="5">Learning Objectives</td></tr>
<tr><td colspan="5">• Given a graph of position or velocity as a function of time, recognize in what time intervals the position, velocity and acceleration of an object are positive, negative, or zero and sketch a graph of each quantity as a function of time PS2.A
• Represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. PS2.A
• Understand and apply the relationship between the net force exerted on an object, its inertial mass, and its acceleration to a variety of situations. PS2.A
• 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-PS2-1
• Predict the change in momentum of an object from the average force exerted on the object and the interval of time during which the force is exerted. PS2.A
• 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-PS2-2</td></tr>
</table>

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying out Investigations (pp. 59- 61, NRC, 2012) 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. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on	**PS2.A: Forces and Motion** (pp. 114-116, NRC, 2012) • Newton's second law accurately predicts changes in the motion of macroscopic objects. (SLO 1, 2 & 3),(HS-PS2-1) • Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (SLO 5),(HS-PS2-2) • If a system interacts with objects outside itself, the total momentum of the system can change; however, any such	**Cause and Effect** (pp. 87-89, NRC, 2012) • 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. (HS-PS2-3) **Systems and System Models** (pp. 91-94, NRC, 2012) • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2)

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-PS2-1),(HSPS2-3) **Analyzing and Interpreting Data** (pp. 61-63, NRC, 2012) Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze 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. (SLO 1, 2 & 3), (HS-PS2-1) **Using Mathematics and Computational Thinking** (pp. 64-67, NRC, 2012) Mathematical and computational thinking at the 9– 12 level 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	change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3),(SLO 5) **ETS1.A: Defining and Delimiting an Engineering Problem** (pp. 204-206, NRC, 2012) • 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** (pp. 208- 210, NRC, 2012) • 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. (HS-PS2-3)	- ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** (pp. 96-101, Appendix H: NRC, 2013) • Theories and laws provide explanations in science. (HS-PS2-1) • Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1)

model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Use mathematical representations of phenomena to describe explanations. (SLO 1, 2 & 4), (HS-PS2-2) **Constructing Explanations and Designing Solutions** (pp. 67-71, NRC, 2012) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3		
Common Core		
• **Common Core Writing Standards:** WHST.11-12.7 WHST.11-12.9 • **Common Core Reading Standards:** RST.11-12.1, RST.11-12.7		

Content Area:	Physics		Grade(s)	10, 11, 12
Unit Plan 2 Title:	Types of Interactions	Time Frame	12 Weeks	
Learning Objectives				

- Calculate the gravitational force two objects exert on each other in a uniform field. PS2.B 2
- Use mathematical representations of Newton's Law of Gravitation to describe and predict the gravitational forces between objects. HS-PS2-4 3
- Relate the period, orbital radius and speed of an object in a circular orbit, and use the model speed = 2πR/T to predict unknown quantities. Teacher Note: Students connect this concept to Kepler's third law by replacing the mass of the earth with the mass of the sun and let R represent the radius of orbit of the planet being studied. PS2.B, ESS1.B 4
- Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. HS-ESS1-4 5
- Represent and describe the two types of forces that a surface can exert on an object - a normal force, and a friction force parallel to the surface and dependent on the normal force and textures of the two surfaces. PS2.A 6 Use Newton's Second Law along with the mathematical relationship among friction force and normal force to predict unknown quantities involving one-dimensional motion with constant velocity and one-dimensional PS2.A
- Explain contact forces (tension, friction, normal) as arising from interatomic electric forces and their certain directions. PS1.A 8
- Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* HS-PS2-6

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking Mathematical and computational thinking at the 9– 12 level 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. (HS-PS2- 4) (HS-ESS1-4), (SLO 1, 2, 5 & 6)	**PS2.A: Forces and Motion** • Newton's second law accurately predicts changes in the motion of macroscopic objects. (SLO 1, 2 & 3) 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. • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. 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	**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 and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2) **Structure and Function** • Investigating or designing new systems or structures requires a detailed examination of

Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • 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 orally, graphically, textually, and mathematically). (HS-PS2-6)	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) 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. (HS-ESS1-4), (SLO 6)	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) **Scale, Proportion, and Quantity** • Algebraic thinking is used to examine exponential growth). (HS-ESS1-4) -- ***Connections to Nature of Science*** **Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. (HS-PS2-1) • Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-4)
Common Core		
• **Common Core Writing Standards:** WHST.11-12.2 WHST.11-12.7 WHST.11-12.8 WHST.11-12.9 • **Common Core Reading Standards:** RST.11-12.1, RST.11-12.7		

Content Area:	Physics		Grade(s)	10, 11, 12
Unit Plan 3 Title:	Energy	Time Frame	2 Weeks	
Learning Objectives				

- Identify and quantify the various types of energies within a system of objects in a well-defined state, such as elastic potential energy, gravitational potential energy, kinetic energy, and thermal energy and represent how these energies may change over time. PS3.A, PS3.B 2
- Calculate changes in kinetic energy and gravitational potential energy of a system using representations of that system. PS3.A 3
- Construct an explanation, using atomic-scale interactions and probability, of how a closed system approaches thermal equilibrium when after energy is transferred to it or from it in a thermal process. PS3.A 4
- 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-PS3-2 5
- 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-PS3-1

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 9–12 builds on K–8 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. • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (SLO 1), (HSPS3-2) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems 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.	**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),(HS-PS2-5) • 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**	**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. (HSPS2-5) • 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) **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

• 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-PS3-3) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9– 12 level 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. • Create a computational model or simulation of a phenomenon, designed device, process, or system. (SLO 1 & 2) (HS-PS3-1), (HS-PS3-2) **Constructing Explanations and Designing Solutions**	• “Electrical energy” may mean energy stored in a battery or 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)	problem. (HS-PS2-6) --- ***Connections to Nature of Science*** **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)

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • 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)		
Common Core		
• **Common Core Writing Standards:** WHST.11-12.7, WHST.9-12.9 • **Common Core Reading Standards:** RST.11-12.1, RST.11-12.7		

Content Area:	Physics		Grade(s)	10, 11, 12
Unit Plan 4 Title:	Electricity and Magnetism	Time Frame	7 Weeks	

Learning Objectives

- 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-PS3-5 2
- Use mathematical representations of Coulomb's Law to describe and predict the electrostatic forces between objects. HS-PS2-4 3
- Make predictions about the sign and relative quantity of net charge of objects or systems after various charging processes. PS2.B 4
- Construct an explanation of a model of electric charge, and make a qualitative prediction about the distribution of positive and negative electric charges within neutral systems as they undergo various processes. PS2.B 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-PS2-5 6

- Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. HS-PS2-5
- Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy HS-PS2-6

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems 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. • 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-PS2-5) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9– 12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear	**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),(HS-PS2-5) • 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** • "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. (secondary to HS-PS2-5) PS3.C:	**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. (HSPS2-5) • 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) **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)

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. (HS-PS2- 4) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • 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 orally, graphically, textually, and mathematically). (HS-PS2-6) **Developing and Using Models** Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables	**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)	

between systems and their components in the natural and designed worlds. • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-5)		

Common Core
• **Common Core Writing Standards:** WHST.9-12.9, WHST.11-12.2, WHST.11-12.7, WHST.11-12.8, WHST.9-10.10 • **Common Core Reading Standards:** RST.11-12.1

Content Area:	Physics		Grade(s)	10, 11, 12
Unit Plan 5 Title:	Waves and their Applications	Time Frame	5Weeks	

Learning Objectives

- Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. HS-PS4-1 2
- Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. HS-PS4-4 3
- Distinguish between models of radiant energy, and use the scale of the problem to determine at what regimes a particle or wave model is more appropriate. PS4.B 4
- Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. HS-PS4-3 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-PS4-5
- Evaluate questions about the advantages of using a digital transmission and storage of information. HS-PS4-2

Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Asking Questions and Defining Problems	**PS3.D: Energy in Chemical Processes** • Solar cells are human-made devices that	**Cause and Effect** • Empirical evidence is required to differentiate

Asking questions and defining problems in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. • Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. (HSPS4-2) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9- 12 level 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 or design solutions to describe and/or support claims and/or explanations. (HS-PS4-1) **Engaging in Argument from**	likewise capture the sun's energy and produce electrical energy. (secondary to HS-PS4-5) **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) • Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2),(HS-PS4-5) • [From the 3–5 grade band endpoints] Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3) PS4.B: **Electromagnetic Radiation** • Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining m any features of electromagnetic radiation, and the particle model explains other features. (HS-	between cause and correlation and make claims about specific causes and effects. (HSPS4-1) • 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-PS4-4) • Systems can be designed to cause a desired effect. (HS-PS4-5) 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-PS4-3) **Stability and Change** • Systems can be designed for greater or lesser stability. (HS-PS4-2) Energy and Matter • Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems. (HS-ESS1-2) - ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D). (HS-PS4-5)

Evidence

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.

• Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-PS4-3)

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.

• Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4)

• Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually,

PS4-3)

• When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4)

• Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5) PS4.C**:**

Information Technologies and Instrumentation

• Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)

ESS1.A: The Universe and Its Stars

• The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2)

• The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of

Influence of Engineering, Technology, and Science on Society and the Natural World

• Modern civilization depends on major technological systems. (HS-PS4-2),(HS-PS4-5) • Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS4-2)

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Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

• Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-2**)**

Connections to Nature of Science Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

• A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not

and mathematically). (HS-PS4-5) **Constructing Explanations and Designing Solution** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS1-2)	spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (HS-ESS1-2) • Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2) PS4.B **Electromagnetic Radiation** • Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (secondary to HS-ESS1-2)	accommodate, the theory is generally modified in light of this new evidence. (HS-PS4- 3) **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-ESS1-2) • Science assumes the universe is a vast single system in which basic laws are consistent. (HSESS1-2)
Common Core		
• **Common Core Writing Standards:** WHST.9-12.2, WHST.11-12.8 • **Common Core Reading Standards:** RST.9-10.8, RST.11-12.1, RST.11-12.7, RST.11-12.8		

III. Methods of Student Evaluation

Assessment can be divided into two general categories: formal (graded) and informal/classroom-based (both graded and ungraded). The key to effectively assessing a student's mastery of skills is to match the assessment method to the learning objective.

Formal Assessments

- Evaluation
- Class participation
- Creative assignments
- Homework and classwork assignments
- Reports and presentations
- Research methodology
- Technological applications
- Unit tests
- Various speaking and listening assignments
- Multiple choice exams
- Quizzes (announced and unannounced)
- Essays
- Formal lab reports
- Scientific journal reviews
- Projects
- Short answer and problem solving tests
- Tests and quizzes on blackboard
- Case Study analysis

Informal Assessments

- Instructor's observations of note-taking, and organization of notebooks and assignments
- Cooperative learning activities, including labs
- Creative project assignments
- Laboratory behavior
- Observing citizenship and appropriate social responses
- Instructor's observations of time management skills

Mastering of the core proficiencies of Biology shall be evaluated in accordance with the general grading policies as listed in the student handbook:

- Tests – 40%
- Laboratory Reports and Projects – 20%
- Quizzes – 20%
- Class Participation – 10%

IV. Instructional Strategies Based on Instructional Goals

- Graphs and other visuals
- Engaging in discussions
- Reading silently and aloud
- Listening and speaking activities
- Watching and responding to media
- Brainstorming
- Listening
- Mapping
- Revising and editing
- Participating in small and large groups
- Researching to make connections to texts and classroom discussions
- Collaborative projects
- Answering questions (oral and written)
- Summarizing
- Debating
- Analyzing texts, discussions, etc.
- Peer teaching
- Competing in teams/debating
- Playing games
- Creating games

- Note taking and note making
- Writing

V. Scope and Sequence

Key: I – Introduced, D-developed in Depth, R-Reinforced

SKILLS TO BE LEARNED	11	12
Understanding the relationship between science and technology.	I D,R	I D,R
Logically gather, order and interpret data through an appropriate use of measurements and tools.	I,D,R	I D,R
Correctly identify and manipulate mathematical formulas.	I,D,R	I D,R
Identify, explain and use metric and SI units of measurement	D,R	D,R
Understand and use dimensions of physical quantities and relate them to the base quantities and their SI units.	I,D,R	I D,R
Describe and explain vector algebra, trigonometric ratios, simple derivatives and simple integrals.	I,D, R	I D,R
Demonstrate an understanding of kinematics and apply vector algebra to the solution of problems in one and two dimensions	I,D,R	I D,R
Demonstrate an understanding of forces and fields of force such as gravitation, and electrical and how they relate to potential and kinetic energies..	I,D,R	I D,R
Explain and solve problems using the conservation of linear and angular momenta.	I,D,R	I,D,R
Calculate and solve problems involving weight, normal force, friction, and inclined planes.	I,D,R	I,D,R
Understand circular motion, turning forces and rotational motion.	I,D,R	I D,R
Use the concept of centripetal force to perform calculations on objects moving in a circle and to explain the motion of celestial bodies.		
Describe the conditions for objects to be in static equilibrium and solve problems involving systems of macroscopic objects in equilibrium.	I,D,R	I D,R
Demonstrate an understanding of an object undergoing simple harmonic motion and calculate quantities such as its frequency, energy, and amplitude.	I,D,R	I D,R
Demonstrate an understanding of wave motion and apply these principles to mechanical waves and sound.	I,D,R	I,D,R

Explain and solve problems using the conservation of mechanical energy	I,D,R	I D,R
Explain the Doppler effect and perform calculations to determine the perceived frequencies or motion of the sound emitter or the observer.	I,D,R	I,D,R
Calculate the electric field and force at a point due to an array of electric point charges	I,D,R	I,D,R
Calculate the potential difference between two points due to an array of electric point charges.	I,D,R	I,D,R
Set up a steady state direct current circuit from a circuit diagram and analyze the circuit using Ohms law.	I,D,R	I,D,R
Analyze a direct current circuit consisting of voltage sources and resistors using Kirchhoff's rules.	I,D,R	I,D,R

VI. Pacing Chart

<u>Marking Period 1</u>

- *Unit 1*
- **Measurements and Units:** (2 weeks) Student will review SI and metric units of measurements and their prefixes. Student will be able to use and convert between common metric prefixes. Student will be able to estimate the maximum error in a measurement and propagate the error in the calculation of a related quantity. Student will be able demonstrate an understanding of errors in data collection through experimentation and the reporting of such data and results to the correct number of significant figures using decimal or scientific notation. Student will be able to perform dimensional analysis in formulas and derived units verification.
- **Kinematics in One Dimension:** (2 weeks) Student will be able to describe one dimensional motion and differentiate between vector and scalar quantities. Student will be able to understand the meaning of the following quantities; displacement, distance, speed, velocity acceleration and deceleration. Student will be able to carry out calculations of the said motion quantities stating the results in the correct metric units. Student will be able to describe motion using the common equations and when necessary derive equations needed to solve given kinematics problems. Student will

be able to analyze motion graphs and carry out calculations based on the graphs or given data. Student will be able to analyze motion along the x-axis and y-axis separately.

- **Kinematics in Two Dimension: (**3 weeks**)** Student will be able to define the six common trigonometric functions (sin, cos, tan, cot, sec and cosec) using a right angled triangle and convert between trigonometric functions and angles in degrees using a scientific calculator. Student will be able to use the unit circle. Student will be able to do vector algebra; addition, subtraction and multiplication of vector quantities. Student will be able describe projectile motion and solve projectile motion problems involving macroscopic objects. Students will be able to describe and solve relative motion problems.
- *Unit 2*
  - **Dynamics: Newton's Laws of Motion:** (2 weeks) Student will be able describe force, mass and inertia and relate them to Newton's first law of motion. Student will be able differentiate between kinematics and dynamics, define the net force on an object, and calculate its consequent acceleration according to Newton's second law.

<u>Marking Period 2</u>

- *Unit 2*
  - **Newton's Second and Third Laws:** (1 week) Student will be able to understand the concept of a force exerted on object by another object or exerted on an object due to its presence in a force field. Student will be able to identify action-reaction pairs and understand the concept of a normal force. Student will be able analyze forces on an object using free-body diagrams.
  - **Friction and Motion** (1 week) Student will be able to describe friction conceptually and mathematically and describe how its effect can be reduced. Student will be able to solve force and motion problems involving friction on horizontal surfaces and on inclines.
  - **Circular Motion and Gravitation:** (3 weeks) Student will be able to explain the acceleration of an object moving in a circle at constant speed. Student will be able to describe how centripetal acceleration depends upon the object's speed and the radius of the circle. Student will be able to recognize the direction of the force that causes centripetal acceleration. Student will be able to relate Kepler's laws of planetary motion to Newton's law of universal gravitation. Student will be able to calculate the periods and speeds of orbiting objects. Student will be able to describe the method Cavendish used to measure G and the results of knowing G. Student will be able to solve

problems involving orbital speed and period. Student will be able to relate weightlessness to objects in free fall. Student will be able to contrast Newton's and Einstein's views about gravitation.

- *Unit 3*
  - **Work, Energy and Power:** (2 weeks) Student will be able to describe the relationship between work and energy. Student will be able to display an ability to calculate work done by a constant or varying force. Student will be able to identify conservative and non-conservative forces. Student will be able to differentiate between kinetic and potential energy and demonstrate the ability to solve problems based on energy conservation. Student will be able to solve energy conservation problems involving dissipative forces. Student will be able differentiate between energy and power and to solve problems involving power.
- *Unit 1*
  - **Linear Momentum and Collisions** (2 weeks) Student will be able define linear momentum and impulse. Student will describe the conservation of linear momentum. Student will describe collisions and impulse. Student will be able solve problems involving the conservation of linear momentum, elastic collisions and inelastic collisions. Student will be able to solve problems involving collisions in two dimensions. Student will be able to describe the center of mass and center of gravity of single objects or a system of objects. Student will be able to calculate the coordinates of the center of mass of a system of objects.

Marking Period 3

- *Unit 2*
  - **Rotational Motion** (3 weeks) Student will describe the radian as a unit of angular displacement. Student will be able to define the angular quantities of acceleration, frequency, period, velocity and relate them to their linear analogues. Student will solve problems involving the kinematics of rotational motion. Student will be able describe torque and rotational inertia and solve problems involving rotational dynamics. Student will be able to describe rotational kinetic energy and relate it to the translational kinetic energy of a rolling object. Student will describe angular momentum and its conservation and solve angular momentum problems. Student will describe the vector nature of angular quantities.
  - **Static Equilibrium** (2 weeks) Student will be able to describe the conditions required for static equilibrium and solve problems involving static equilibrium. Student will be able to understand the concept of elasticity in materials and describe Hooke's law, stress, strain, and the elastic modulus. Student will be able to describe the

deformation of objects subjected to tensile, compressive, and shear stresses and define shear and bulk modulus. Student will be able to describe fracture and solve problems involving fracture.

- *Unit 5*
  - **Vibrations and Waves** (3 weeks) Student will able to describe simple harmonic motion (SHM) using a spring mass system. Student will be able to describe energy in a simple harmonic oscillator using the said spring mass system. Student will be able to understand the sinusoidal nature of SHM and demonstrate it by comparison to uniform circular motion. Student will be able to solve problems concerning the design and operation of the simple pendulum. Student will be able to describe forced vibrations and resonance. Student will be able to describe and solve problems involving the energy, interactions and motion of mechanical waves. Student will be able to describe standing waves. Student will be able to demonstrate an understanding of standing waves and solve problems involving their resonance and frequency.
  - **Sound (**1 week) Student will be able to describe the characteristics of sound and calculate its speed, frequency and wavelength. Students will be able to differentiate between sound intensity and loudness and calculate the sound level in decibels. Student will be able to describe the sources of sound and determine its frequency from standing wave diagrams.

<u>Marking Period 4</u>

- *Unit 5*
  - **Sound (**1 week) Student will be able to describe the interference of sound waves and calculate the beat frequency. Student will be able to describe the Doppler Effect and perform calculations using the associated equations. Student will be able to describe the applications of sound waves.
- *Unit 4*
  - **Electric Charge and Fields**: (3 weeks) Student will be able to understand the basic properties of electric charge. Student will differentiate between conductors and insulators. Student will be able to calculate the net electric force due to an array of electric point charges using Coulomb's law. Student will be able to describe electric fields and calculate the electric field at a point due to an array of electric point charges. Student will be able to compare electric force with gravitational force.
  - **Electric Potential**: (2 weeks) Student will be able to differentiate between electric potential energy, electrical potential and potential difference. Student will be able to understand the relationship between electric potential and

electric field. Student will be able to calculate the potential difference between two points due to an array of electric point charges.

- **Electric Current and Resistors**: (2 weeks) Student will be able identify sources of electric current such as electric battery and describe their operation. Student will be able to define the electric current as a flow of charge. Student will be able to describe Ohm's law and understand the color coding of resistors. Student will be able to analyze direct current (dc), steady state circuits consisting of voltage sources, resistors and switches. Student will be able to calculate voltage and current in the dc circuits. Student will be able to understand resistivity and calculate the resistivity of materials. Student will be able to calculate electric energy and power.

VII. Proficiencies

1. Logically gather order and interpret data through an appropriate use of measurements and tools.
2. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science. Students will use standard safety practices for all classroom laboratory and field investigations. Students will identify and investigate problems scientifically.
3. Students will use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.
4. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.
5. Students will communicate scientific investigations and information clearly.
6. Students will analyze how scientific knowledge is developed.
7. Students will understand important features of the process of scientific inquiry.
8. Demonstrate an understanding of the nature, types and causes of motion.
9. Demonstrate an understanding of the nature of gravitational, electromagnetic and nuclear forces.
10. Explain the law of conservation of energy and relate it to energy transformations.
11. Demonstrate an understanding of the characteristics of work and energy.
12. Describe and identify the components of the electromagnetic spectrum
13. Students will analyze the relationships between force, mass, gravity, and the motion of objects. Students will evaluate the significance of energy in understanding the structure of matter and the universe.
14. Students will evaluate the forms and transformations of energy.
15. Students will analyze the properties and applications of waves.
16. Students will analyze dc electric circuits containing resistors.
17. Students will analyze the properties of electric fields.

18. Examine contributions of important scientists to the development of physics principles.