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Kingsway Regional School District

Committed to Excellence

Course Name: AP Physics 1	**Grade Level(s):** 9-12
Department: Science	**Credits:** 1.3
BOE Adoption Date: October 2016	**Revision Date(s):** October 2019; September 2022

ABSTRACT

AP Physics 1: Algebra-based and AP Physics 2: Algebra-based are the equivalent of the first and second semesters of introductory, algebra-based college courses. Because these courses are intended to be yearlong courses, teachers have time to foster deeper conceptual understanding through student-centered, inquiry-based instruction. Students have time to master foundational physics principles while engaging in science practices to earn credit or placement.

AP Physics 1 is an algebra-based, introductory college-level physics course that explores topics such as: Newtonian mechanics (including rotational motion); work, energy, and power; mechanical waves and sound; and introductory, simple circuits. Through inquiry-based learning, students will develop scientific critical thinking and reasoning skills.

Students explore principles of Newtonian mechanics (including rotational motion); work, energy, and power; mechanical waves and sound; and introductory, simple circuits. The course is based on six Big Ideas, which encompass core scientific principles, theories, and processes that cut across traditional boundaries and provide a broad way of thinking about the physical world. The following are Big Ideas:

- Objects and systems have properties such as mass and charge. Systems may have internal structure.
- Fields existing in space can be used to explain interactions.
- The interactions of an object with other objects can be described by forces.
- Interactions between systems can result in changes in those systems.

• Changes that occur as a result of interactions are constrained by conservation laws.

• Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena.

Students establish lines of evidence and use them to develop and refine testable explanations and predictions of natural phenomena. Focusing on these disciplinary practices enables teachers to use the principles of scientific inquiry to promote a more engaging and rigorous experience for AP Physics students. Such practices require that students:

- Use representations and models to communicate scientific phenomena and solve scientific problems;
- Use mathematics appropriately;
- Engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course;
- Plan and implement data collection strategies in relation to a particular scientific question;
- Perform data analysis and evaluation of evidence;
- Work with scientific explanations and theories; and
- Connect and relate knowledge across various scales, concepts, and representations in and across domains.

Twenty-five percent of instructional time is devoted to hands-on laboratory work with an emphasis on inquiry-based investigations. Investigations require students to ask questions, make observations and predictions, design experiments, analyze data, and construct arguments in a collaborative setting, where they direct and monitor their progress.

Proficiencies and Pacing
Course Title: Advanced Placement Physics 1
Prerequisite(s): Geometry

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
Unit 1: Kinematics Big Idea 3	20 Days Sept 8- Oct 3	**Subject Area:** **Essential Knowledge:** 3.A.1 **Science Practices:** 1.5, 2.1, 2.2, 1.1, 4.2, 5.1, 1.4, **Interdisciplinary:** **NJSLS Math:** NJSLS-A-SSE.B.3 NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1 NJSLS-A-REI.B.3 NJSLS-A-REI.B.4 NJSLS-A-REI.C.6 NJSLS-F-IF.B.4 NJSLS-F-IF.C.8 NJSLS-F-IF.C.9 NJSLS-F-LE.A.1 NJSLS-F-LE.A.2 NJSLS-F-TF.A.1 NJSLS-F-TF.A.4 NJSLS-G-SRT.C.7 NJSLS-G-SRT.D.11 NJSLS-S-ID.C.7 NJSLS-S-ID.C.8	• Understand the general relationships among position, velocity, and acceleration for the motion of a particle along a straight line, so that given a graph of one of the kinematic quantities of position, velocity, and acceleration, as a function of time, students can recognize in what time intervals the other two are in (positive, negative, or zero) and can identify or sketch a graph of each as a function of time. • Understand the special case of motion with constant acceleration, so they can use the following equations to solve problems involving one-dimensional motion with constant acceleration. • Understand the special case of motion with constant acceleration, so they can use the three main kinematics equations to solve problems involving one-dimensional	Course Introduction Physics conventions Measurements Significant figures Orientation Intro to center of mass Objects and systems Inertial frames Coordinate system Scalars and vectors Kinematic variables and rates Position Distance Displacement Speed, Velocity, Acceleration Deriving kinematic equations and problem solving techniques One-dimensional kinematics Qualitatively describing motion associated with experimental results and real world examples Graphical motion analysis Position, velocity, and acceleration time graphs Freefall Acceleration of gravity Two-dimension kinematics Vector components Vector addition Relative motion Projectile motion

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
		NJSLS-S-ID.C.9 **NJSLS ELA Literacy:** NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E NJSLS-W.11-12.2.A NJSLS-W.11-12.2.B NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2.A NJSLS-L.11-12.6 **Technology:** NJSLS.8.1.12.DA.1 NJSLS.8.1.12.F.1	motion with constant acceleration. • Understand the motion of projectiles in a uniform gravitational field, so they can write down expressions for the horizontal and vertical components of velocity and position as functions of time, and sketch or identify graphs of these components.	
Unit 2: Dynamics : Newton's Laws of Motion Big Ideas 1, 2, 3, 4	25 Days Oct 6-Nov 14	**Subject Area:** **Essential Knowledge:** 1.C.1, 2.B.1, 3.A.2, 3.A.3, 3.A.4, 3.B.1, 3.B.2, 3.C.4, 4.A.1, 4.A.2, 4.A.3 **Science Practices:** 4.2, 2.2, 7.2, 6.4, 1.4, 1.1, 6.1, 6.2, 1.5, 5.1, 5.3 **Interdisciplinary:**	• Analyze situations in which a particle remains at rest, or moves with constant velocity, under the influence of several forces. • Understand how Newton's Second Law, applies to an object subject to forces such as gravity, the pull of strings, or contact forces, so they can draw a well-labeled, free-	Inertial mass, Law of Inertia Force Agent and object Contact forces Long-range forces Gravity field Identifying forces Weight Tension Normal force Force of springs Friction

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
		NJSLS Math: NJSLS-A-SSE.B.3 NJSLS-A-APR.B.3 NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1 NJSLS-A-REI.B.3 NJSLS-A-REI.B.4 NJSLS-A-REI.C.6 NJSLS-F-IF.B.4 NJSLS-F-IF.C.8 NJSLS-F-IF.C.9 NJSLS-F-LE.A.1 NJSLS-F-LE.A.2 NJSLS-F-TF.A.1 NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-G-SRT.C.7 NJSLS-G-SRT.D.11 NJSLS-S-ID.C.7 NJSLS-S-ID.C.8 NJSLS-S-ID.C.9 **NJSLS ELA Literacy:** NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E NJSLS-W.11-12.2 NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4	body diagram showing all real forces that act on the object, and/or write down the vector equation associated with the object and the forces acting upon it. • Understand the significance of the coefficient of friction and drag, so they can analyze situations in which an object moves along a rough inclined plane of horizontal surface and/or when a retarding force is applied to an object's motion. • Understand the significance of the coefficient of friction, so they can analyze under what circumstances an object will start to slip, or calculate the magnitude of the force of static friction. • Know that the tension is constant in a light string that passes over a massless pulley and be able to use this fact in analyzing the motion of a system of two objects joined by a string.	Drag Objects and systems Force vectors Free-body diagrams Newton's Second Law Newton's Third Law Problem solving Net force Statics Dynamics Inclines Compound bodies Advanced equilibrium and dynamics problems involving a variety of forces and interacting objects

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
		NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2 NJSLS-L.11-12.6 **Technology:** NJSLS.8.1.12.DA.1 NJSLS.8.1.12.F.1	• Solve problems in which application of Newton's laws leads to two or three simultaneous linear equations involving unknown forces or accelerations.	
Unit 3: Circular Motion and Universal Law of Gravitation Big Ideas 1, 2, 3, 4	31 Days Nov 17-Jan 12	Subject Area: **Essential Knowledge**: 1.C.3, 2.B.1, 2.B.2, 3.A.3, 3.B.1, 3.B.2, 3.C.1, 3.C.2, 3.G.1, 4.A.2 **Science Practices:** 6.4, 7.2, 4.2, 7.1, 2.2, 1.4, **Interdisciplinary:** **NJSLS Math:** NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1 NJSLS-A-REI.C.6 NJSLS-F-BF.A.1 NJSLS-F-TF.A.1 NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-G-SRT.C.7 NJSLS-G-SRT.D.11 NJSLS-G-C.A.4 NJSLS-S-ID.A.1	• Understand the uniform circular motion of a particle, so they can relate the radius of the circle and the speed or rate of revolution of the particle to the magnitude of the centripetal acceleration, as well as describe the direction of the velocity or acceleration at any point in time. • Understand the uniform circular motion of a particle, so they can analyze situations in which an object moves with specified acceleration under the influence of one or more forces so they can determine the magnitude and direction of the net force, or of one of the forces that makes up the net force, in situations such as the motion in a horizontal circle	Uniform circular motion Period Tangential velocity Centripetal acceleration Centripetal force Force problems involving uniform circular motion Apparent weight in circular motion Long and short range gravitational fields

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
		NJSLS-S-ID.A.2 NJSLS-S-ID.A.3 NJSLS-S-ID.A.4 NJSLS-S-ID.B.6 NJSLS-S-ID.C.7 NJSLS-S-ID.C.8 NJSLS-S-ID.C.9 **NJSLS ELA Literacy:** NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E NJSLS-W.11-12.2 NJSLS-W.11-12.2 NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2.A NJSLS-L.11-12.6 **Technology:** NJSLS.8.1.12.DA.1 C NJSLS.8.1.12.F.1	(e.g., mass on a rotating merry-go-round, or car rounding a banked curve) or a vertical circle (e.g., mass swinging on the end of a string, cart rolling down a curved track, rider on a Ferris wheel). • Know Newton's Law of Universal Gravitation, so they can determine the force that one symmetrical mass exerts on another, as well as the strength of the gravitational field at a specified point outside a spherically symmetrical mass. Use this information to derive Kepler's Law.	
Unit 4: Work, Energy, Power, and Linear Momentum	18 days Jan 13 - Feb 6	Subject Area: Essential Knowledge: 3.E.1, 4.C.1, 4.C.2, 5.A.2, 5.B.1, 5.B.2, 5.B.3, 5.B.4, 5.B.5, 5.D.1, 5.D.2, 3.D.1,	• Should understand the definition of work, including when it is positive, negative, or zero, so they can calculate the work done by a specified constant force on an object that undergoes a specified	Energy Energy model Internal energy Total mechanical energy

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
Big Ideas 3, 4, 5		3.D.2, 4.B.1, 4.B.2, 5.D.3 **Science Practices:** 1.4, 2.2, 1.5, 6.4, 7.2, 5.1, 4.2, 2.1, 1.1, 7.1, 3.2, 5.3, 4.1, 4.3, 2.1 **Interdisciplinary:** **NJSLS Math:** NJSLS-A-SSE.A.1 NJSLS-A-SSE.A.2 NJSLS-A-SSE.B.3 NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1 NJSLS-A-REI.B.3 NJSLS-A-REI.B.4 NJSLS-A-REI.C.6 NJSLS-F-IF.C.8 NJSLS-F-IF.C.9 NJSLS-F-BF.A.1 NJSLS-F-BF.B.4 NJSLS-F-BF.B.5 NJSLS-F-LE.A.1 NJSLS-F-LE.A.2 NJSLS-F-TF.A.1 NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-F-TF.B.5 NJSLS-F-TF.B.7 NJSLS-G-SRT.D.11	displacement, as well as understand how to calculate work done via graphical analysis. • Understand and be able to apply the work-energy theorem, so they can calculate the work performed by the net force, or by each of the forces that make up the net force, on an object that undergoes a specified change in mechanical energy. • Understand the concepts of mechanical energy and of total energy, so they can describe and identify situations in which mechanical energy is converted to other forms of energy or changed by friction or by a specified externally applied force. • Understand the definition of power, so they can calculate the power required to maintain the motion of an object with constant or variable velocity.	Kinetic energy Potential energy Gravitational Elastic Work Dot product of vectors Conservative forces Non-conservative forces Constant force Variable force Work Kinetic Energy Theorem Conservation of energy Conservative forces Non-conservative forces Power Graphing energy, work, and power Linear momentum Impulse Open and closed systems Conservation of linear momentum Elastic collisions Inelastic collisions Perfectly inelastic collisions Explosions Energy in collisions Graphing

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
		NJSLS-S-ID.B.6 NJSLS-S-ID.C.7 NJSLS-S-ID.C.8 NJSLS-S-ID.C.9 **NJSLS ELA Literacy:** NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.E NJSLS-W.11-12.2 NJSLS-W.11-12.2 NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2 NJSLS-L.11-12.6 **Technology:** NJSLS.8.1.12.DA.1 NJSLS.8.1.12.F.1	• Understand impulse and linear momentum, so they can relate mass, velocity, and linear momentum for a moving object, and calculate the total linear momentum of a system of objects. • Understand linear momentum conservation, so they can apply linear momentum conservation to one-dimensional elastic and inelastic collisions and two-dimensional completely inelastic collisions.	Impulse
Unit 5: Unit 5 Torque and Rotational Motion Big Ideas 3, 4, 5	13 Days Feb 9 - Feb 27	**Subject Area:** **Essential Knowledge:** 3.F.1, 3.F.2, 3.F.3, 4.A.1, 4.D.1, 4.D.2, 4.D.3, 5.E.1, 5.E.2 **Science Practices:** 1.4, 2.3, 4.1, 4.2, 5.1, 2.2, 5.3, 1.2, 6.4, 3.2, 7.2, **Interdisciplinary**:	• Understand the concept of torque, so they can calculate the magnitude and direction of the torque associated with a given force. • Analyze problems in statics, so they can state the conditions for translational and rotational equilibrium of a rigid object.	Center of mass Rotational objects viewed as systems Rotational kinematics Angular displacement Angular velocity Angular acceleration Related tangential quantities Moment of inertia Parallel axis theorem

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
		NJSLS Math: NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1 NJSLS-A-REI.C.6 NJSLS-F-BF.A.1 NJSLS-F-BF.A.2 NJSLS-F-TF.A.1 NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-G-SRT.C.7 NJSLS-G-SRT.C.8 NJSLS-G-SRT.D.11 NJSLS-G-C.A.4 NJSLS-S-ID.A.1 NJSLS-S-ID.A.2 NJSLS-S-ID.A.3 NJSLS-S-ID.A.4 NJSLS-S-ID.B.6 NJSLS-S-ID.C.7 NJSLS-S-ID.C.8 NJSLS-S-ID.C.9 **NJSLS ELA Literacy:** NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E NJSLS-W.11-12.2 NJSLS-W.11-12.2 NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7	• Understand the definition and applications of angular momentum including its relationship to torque. • Understand that contact between rolling objects and what they roll against imposes constraints on the change in position (velocity) and angle (angular velocity).	Torque Torque vectors Cross product of vectors Right hand rule Rotational statics Rotational dynamics Conservation of energy in rotation Angular momentum Angular momentum vectors Right hand rule Change in angular momentum Conservation of angular momentum

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
		NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2 NJSLS-L.11-12.6 **Technology:** NJSLS.8.1.12.DA.1 NJSLS.8.1.12.F.1		
Unit 6: Simple Harmonic Motion, Waves, and Sound Big Ideas 3, 5, 6	13 Days March 2- March 18	**Subject Area:** **Essential Knowledge:** 3.B.3, 5.B.2, 5.B.3, 5.B.4, 6.A.1, 6.A.2, 6.A.3, 6.A.4, 6.B.1, 6.B.2, 6.B.4, 6.B.5, 6.D.1, 6.D.2, 6.D.3, 6.D.4, 6.D.5 **Science Practices:** 6.4, 7.2, 4.2, 2.2, 5.1, 6.2, 1.2, 1.4, 2.1, 3.2, , 5.2, 5.3, 1.5, 6.1, **Interdisciplinary:** **NJSLS Mathematics:** NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1 NJSLS-A-REI.C.6 NJSLS-F-IF.A.1 NJSLS-F-IF.A.2 NJSLS-F-IF.A.3	• Understand simple harmonic motion, so they can sketch or identify a graph of displacement as a function of time, and determine from such a graph the amplitude, period, and frequency of the motion, as well as state the relations between acceleration, velocity, and displacement, and identify points in the motion where these quantities are zero or achieve their greatest positive and negative values. • Understand simple harmonic motion, so they can state how the total energy of an oscillating system depends on the amplitude of the motion, sketch or identify a graph of these quantities, while proving that the sum of these quantities is constant.	Restoring forces Hooke's Law Equilibrium Simple harmonic motion Spring Simple pendulum Physical pendulum Period and frequency Force and energy relationships during an oscillation Graphing oscillations Fundamental forces Long range forces Gravity field Mass and weight Newton's Law of Gravity Inverse Square Law Elliptical orbits Kepler's Laws Conservation of angular momentum Conservation of energy

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
		NJSLS-F-IF.B.4 NJSLS-F-IF.C.8 NJSLS-F-IF.C.9 NJSLS-F-TF.A.1 NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-F-TF.B.5 NJSLS-F-TF.B.7 NJSLS-S-ID.B.6 NJSLS-S-ID.C.7 NJSLS-S-ID.C.8 NJSLS-S-ID.C.9 **NJSLS ELA Literacy:** NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E NJSLS-W.11-12.2.A NJSLS-W.11-12.2.B NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2.A NJSLS-L.11-12.6 **Technology:** NJSLS.8.1.12.DA.1 NJSLS.8.1.12.F.1	• Understand the description of traveling waves, so they can sketch or identify graphs that represent traveling waves and determine the amplitude, wavelength, and frequency of a wave from such a graph. • Understand the description of traveling waves, so they can describe reflection of a wave from the fixed or free end of a string. • Understand the physics of standing waves, so they can sketch possible standing wave modes for a stretched string that is fixed at both ends, or a sound wave in a pipe with either open or closed ends, then determine the amplitude, wavelength, and frequency of such standing waves. • Understand the principle of superposition, so they can apply it to traveling waves moving in opposite directions, and describe how a standing	Circular orbits Orbital speed Escape speed Medium Dependence on medium for mechanical waves, but not for electromagnetic waves Mechanical waves Transverse waves Waves on a string Longitudinal waves Sound Period and frequency Wavelength Amplitude Interference Constructive Destructive Superposition Reflection Standing waves Sound specific Resonance Loudness Doppler effect Beats

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
			wave may be formed by superposition. • Understand the interference and diffraction of waves, and how it can affect individual variables relating to waves.	
Unit 7: Electrostatics and Simple Electric (DC) Circuits Big Ideas 1, 3, 5	7 Days March 18-March 27	**Subject Area:** **Essential Knowledge:** 1.B.1, 1.B.2, 1.B.3, 3.C.2, 5.A.2, 1.E.2, 5.B.9, 5.C.3, **Science Practices:** 6.4, 7.2, 6.1, 6.2, 2.2, 4.2, 4.1, 5.1, 1.4, 1.1 **Interdisciplinary:** **NJSLS Math:** NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1 NJSLS-F-LE.A.1 NJSLS-F-LE.A.2 NJSLS-F-TF.A.1 NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-F-TF.B.5 NJSLS-F-TF.B.7 NJSLS-G-SRT.C.7 NJSLS-G-SRT.C.8 NJSLS-G-SRT.D.11	• Understand the concept of electric charge and electric fields, so they can describe the types of charge and the attraction and repulsion of charges, as well as calculate any resulting forces on test or point charges. • Understand the definition of electric current, so they can relate the magnitude and direction of the current to the rate of flow of positive and negative charge. • Apply Ohm's law to direct-current circuits, in order to determine a single unknown current, voltage, or resistance.	Charge Electric field Electric force Conductors and insulators Conservation of charge Charging Conduction Induction Current Batteries and EMF Resistance Ohm's Law Power Kirchhoff's Laws DC resistor circuits

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
		NJSLS-S-ID.A.1 NJSLS-S-ID.A.2 NJSLS-S-ID.A.3 NJSLS-S-ID.A.4 NJSLS-S-ID.B.6 **NJSLS ELA Literacy:** NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E NJSLS-W.11-12.2.A NJSLS-W.11-12.2.B NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2 NJSLS-L.11-12.6 **Technology:** NJSLS.8.1.12.DA.1 NJSLS.8.1.12.F.1		

Unit 1: Kinematics	Recommended Duration: 20 Days: Sept 8- Oct 3
Unit Description: This unit begins with the review of essential physics conventions and the material covered in the summer packet. The unit then addresses the understandings of one and two dimensional kinematics including vector analysis, free fall, and projectile motion. This will be accompanied by the graphical analysis of position, velocity, and acceleration vs. time graphs.	

Essential Questions:	Enduring Understandings:
• What advantages are gained from the use of vectors, as opposed to scalars? • How is velocity fundamentally different from speed, and why is this difference important when solving kinematics problems? • How can accelerated motion in one and two dimensions be described qualitatively, quantitatively, and graphically? • Why is freefall considered a special case of accelerated motion?	• All forces share certain common characteristics when considered by observers in inertial reference frames.

Relevant Standards:	Learning Goals:	Learning Objectives:
Content Standards: **Primary(Power):** Essential Knowledge: • 3.A.1 **Secondary(Supportive):** Science Practices: • 1.5, 2.1, 2.2, 1.1, 4.2, 5.1, 1.4,	• Understand the general relationships among position, velocity, and acceleration for the motion of a particle along a straight line, so that given a graph of one of the kinematic quantities of position, velocity, and acceleration, as a function of time, students can recognize in what time intervals the other two are in (positive, negative, or zero) and can identify or sketch a graph of each as a function of time. • Understand the special case of motion with constant acceleration, so they can use the following equations to solve problems involving one-dimensional motion with constant acceleration.	• (3.A.1.1) The student is able to express the motion of an object using narrative, mathematical, and graphical representations. • (3.A.1.2)The student is able to design an experimental investigation of the motion of an object. • (3.A.1.3) The student is able to analyze experimental data describing the motion of an object, and express the results of the analysis using narrative, mathematical, and graphical representations.

Relevant Standards:	Learning Goals:	Learning Objectives:
	• Understand the special case of motion with constant acceleration, so they can use the three main kinematics equations to solve problems involving one-dimensional motion with constant acceleration. • Understand the motion of projectiles in a uniform gravitational field, so they can write down expressions for the horizontal and vertical components of velocity and position as functions of time, and sketch or identify graphs of these components.	

Formative Assessments	Summative Assessments:	Performance Assessments:	Major Activities/ Assignments (required):
• Two Dimensional Kinematics Quiz • Two Dimensional Kinematics Test	• Video Analysis Lab	• "Where will they meet?" LAB • Graph Matching Lab	• MasteringPhysics Online Assessments • Any 4 of the following 6 AP approved labs which accompany this unit. Some are Open Inquiry (OI), and some are Guided Inquiry (GI) o Meeting Point o Match the Graph (GI) o Free-Fall Investigation o Vector Addition (GI) o Shoot the Target (GI) o Chase Scenario (GI Lab Practicum)

Possible Assessment Modifications /Accommodations/ Differentiation:			
Special Education	ELLs	Struggling Learners	Advanced Learners
• Clarification on questions • Fewer multiple choice • No scantron tests • Extended time for unit test on kinematics • Formatting by skill area • Read directions to student • Eliminating distractors • Corrections for unit test and quizzes • Provide study guide prior to the unit test • No penalty for spelling errors in literacy question • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• Clarification on questions • Fewer multiple choice • No Scantron tests • More picture prompts • More specific concrete questions • Extended time for unit test on forces • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis) • Read directions to student • Eliminating distractors • Retakes for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• Clarification on questions • Extended time for unit test • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis) • Eliminating distractors • Corrections for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • Calculator and equation sheet provided in class for assessments	• Corrections on unit test • Challenge question on unit test • Calculator and equation sheet provided in class for assessments

Instructional Strategies (refer to *Robert Marzano's* 41 Elements):
2.6: Identifying critical information 2.7: Organizing students to interact with new knowledge 2.8: Previewing new content 2.9: Chunking content into "digestible bites" 2.10: Processing of new information 2.11: Elaborating on new information 2.12: Recording and representing knowledge 2.13: Reflecting on learning 3.14: Reviewing content 3.15: Organizing students to practice and deepen knowledge 3.16: Using homework 3.17: Examining similarities and differences 3.18: Examining errors in reasoning 3.19: Practicing skills, strategies, and processes 3.20: Revising knowledge 4.21: Organizing students for cognitively complex tasks 4.22: Engaging students in cognitively complex tasks involving hypothesis generation and testing 4.23: Providing resources & guidance

Possible Instructional Modifications /Accommodations/Differentiation:			
Special Education	**ELLs**	**Struggling Learners**	**Advanced Learners**
• Add work areas for relationships and calculations • Highlighted key terms in questions such as: constant changing, uniform etc. • Reword questions using simpler language • Provide copy of on-line resource materials from NJCTL website • Additional time for projects • Review directions	• Provide computer time to work on assigned simulations during class • Provide additional work space for class and homework • Provide copy of on-line resource materials from NJCTL website • Review sessions during SMART • Add work areas for relationships and calculations • Highlighted key terms in	• Provide computer time to work on assigned simulations during class • Provide copy of on-line resource materials from NJCTL website • Allow extended time for balloon car and egg drop design project • Review sessions during SMART prior to unit test • Calculators provided in class • Equation sheet provided in class	• Challenge question on assessments • Hands on activities to extend learning • Calculators provided in class • Equation sheet provided in class

Possible Instructional Modifications /Accommodations/Differentiation:			
Special Education	**ELLs**	**Struggling Learners**	**Advanced Learners**
• Verbal and visual cues • Varied reinforcement of concepts • Concrete examples • Calculators provided in class • Equation sheet provided in class • Preferential seating	questions such as: constant velocity/acceleration/slowing down/no motion etc. • Reword questions using simpler language prior to unit test • Additional time for projects • Review directions • Verbal and visual cues • Varied reinforcement of concepts • Concrete examples • Graphic organizers • Calculators provided in class • Equation sheet provided in class • Preferential seating	• Preferential seating	

Unit Vocabulary:
Essential: Significant figures, systems, inertial reference frames, coordinate system, scalars, vectors, position, distance, displacement, speed, velocity, acceleration, freefall, gravity, relative motion, projectile motion **Non-Essential:** center of mass

Interdisciplinary Connections (Applicable Standards):	**Integration of Technology:**	**21st Century Themes:**	**21st Century Skills:**
NJSLS Math: NJSLS-A-SSE.B.3 NJSLS-A-APR.B.3 NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1	**Technology:** NJSLS.8.1.12.DA.1 Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.	____ Global Awareness ____ Civic Literacy ____ Financial, Economic, Business, & Entrepreneurial Literacy	__x__ Media Literacy __x__ Critical Thinking and Problem Solving ____ Life and Career Skills

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
NJSLS-A-REI.B.3 NJSLS-A-REI.B.4 NJSLS-A-REI.C.6 NJSLS-F-IF.B.4 NJSLS-F-IF.C.8 NJSLS-F-IF.C.9 NJSLS-F-LE.A.1 NJSLS-F-LE.A.2 NJSLS-F-TF.A.1 NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-G-SRT.C.7 NJSLS-G-SRT.C.8 NJSLS-G-SRT.D.11 NJSLS-S-ID.C.7 NJSLS-S-ID.C.8 NJSLS-S-ID.C.9 NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E NJSLS-W.11-12.2.A NJSLS-W.11-12.2.B NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2.A NJSLS-L.11-12.6	NJSLS.8.1.12.F.1 Technology: Proper use of Vernier lab equipment ● Mastering Physics website for additional support and adaptive practice ● Khan Academy videos with assessment (R) ● Proper use of Iclickers (S&A)	____ Health Literacy	__x__ Information & Communication Technologies Literacy __x__ Communication & Collaboration __x__ Information Literacy

Resources:
Texts/Materials: Physics, 7 ed. (Cutnell & Johnson)

Unit 2: Dynamics	25 Days: Oct 6-Nov 14
Unit Description: This unit begins with the review of concepts of objects in motion and causes the students to think about what causes this motion. The unit then addresses the understandings of forces through Newton's 3 laws of motion leading students into the understanding of free body diagrams and the effects they have on objects.	

Essential Questions:	Enduring Understandings:
• How can you utilize Newton's laws of motion to predict the behavior of objects? • Do action-reaction force pairs have a cause-and-effect relationship? Why or why not? • How can free-body diagrams be utilized in the analysis of physical interactions between objects? • Why can't an object exert a force on itself?	• Objects and systems have properties of inertial mass and gravitational mass that are experimentally verified to be the same and that satisfy conservation principles. • A gravitational field is caused by an object with mass. • All forces share certain common characteristics when considered by observers in inertial reference frames. • Classically, the acceleration of an object interacting with other objects can be predicted by using a=F/m. • At the macroscopic level, forces can be categorized as either long-ranged forces or contact forces. • The acceleration of the center of mass of a system is related to the net force exerted on the system, where a=F/m.

Relevant Standards:	Learning Goals:	Learning Objectives:
Content Standards: **Primary(Power):** Essential Knowledge: • 1.C.1, 2.B.1, 3.A.2, 3.A.3, 3.A.4, 3.B.1, 3.B.2, 3.C.4, 4.A.1, 4.A.2, 4.A.3 **Secondary(Supportive):** Science Practices: • 4.2, 2.2, 7.2, 6.4, 1.4, 1.1, 6.1, 6.2, 1.5, 5.1, 5.3	• Analyze situations in which a particle remains at rest, or moves with constant velocity, under the influence of several forces. • Understand how Newton's Second Law, applies to an object subject to forces such as gravity, the pull of strings, or contact forces, so they can draw a well-labeled, free-body diagram showing all real forces that act on	• (1.C.1.1): The student is able to design an experiment for collecting data to determine the relationship between the net force exerted on an object, its inertial mass, and its acceleration. • (1.C.3.1): The student is able to design a plan for collecting data to measure gravitational mass and to measure inertial mass, and to distinguish between the two experiments. • (2.B.1.1): The student is able to apply **F** = m**g** to calculate the gravitational force on an object with

Relevant Standards:	Learning Goals:	Learning Objectives:
	the object, and/or write down the vector equation associated with the object and the forces acting upon it. • Understand the significance of the coefficient of friction and drag, so they can analyze situations in which an object moves along a rough inclined plane of horizontal surface and/or when a retarding force is applied to an object's motion. • Understand the significance of the coefficient of friction, so they can analyze under what circumstances an object will start to slip, or calculate the magnitude of the force of static friction. • Know that the tension is constant in a light string that passes over a massless pulley and be able to use this fact in analyzing the motion of a system of two objects joined by a string. • Solve problems in which application of Newton's laws leads to two or three simultaneous linear equations involving unknown forces or accelerations.	mass m in a gravitational field of strength g in the context of the effects of a net force on objects and systems. • (3.A.2.1): The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. • (3.A.3.1): The student is able to analyze a scenario and make claims (develop arguments, justify assertions) about the forces exerted on an object by other objects for different types of forces or components of forces. • (3.A.3.2): The student is able to challenge a claim that an object can exert a force on itself. • (3.A.3.3): The student is able to describe a force as an interaction between two objects and identify both objects for any force. • (3.A.4.1): The student is able to construct explanations of physical situations involving the interaction of bodies using Newton's third law and the representation of action-reaction pairs of forces. • (3.A.4.2): The student is able to use Newton's third law to make claims and predictions about the action-reaction pairs of forces when two objects interact. • (3.A.4.3): The student is able to analyze situations involving interactions among several objects by using free-body diagrams that include the application of Newton's third law to identify forces.

Relevant Standards:	Learning Goals:	Learning Objectives:
		• (3.B.1.1): The student is able to predict the motion of an object subject to forces exerted by several objects using an application of Newton's second law in a variety of physical situations with acceleration in one dimension. • (3.B.1.2): The student is able to design a plan to collect and analyze data for motion (static, constant, or accelerating) from force measurements and carry out an analysis to determine the relationship between the net force and the vector sum of the individual forces. • (3.B.1.3): The student is able to re-express a free-body diagram representation into a mathematical representation and solve the mathematical representation for the acceleration of the object. • (3.B.2.1): The student is able to create and use free-body diagrams to analyze physical situations to solve problems with motion qualitatively and quantitatively. • (3.C.4.1): The student is able to make claims about various contact forces between objects based on the microscopic cause of those forces. • (3.C.4.2): The student is able to explain contact forces (tension, friction, normal, buoyant, spring) as arising from interatomic electric forces and that they therefore have certain directions. • (4.A.1.1): The student is able to use representations of the center of mass of an isolated system to analyze the motion of the system qualitatively and semi-quantitatively. • (4.A.2.1): The student is able to make predictions about the motion of a system based on the fact that acceleration is equal to the change in

Relevant Standards:	Learning Goals:	Learning Objectives:
		velocity per unit time, and velocity is the change in position per unit time. • (4.A.2.2): The student is able to evaluate using given data whether all the forces on a system or whether all the parts of a system have been identified. • (4.A.2.3): The student is able to create mathematical models and analyze graphical relationships for acceleration, velocity, and position of the center of mass of a system and use them to calculate properties of the motion of the center of mass of a system. • (4.A.3.1): The student is able to apply Newton's second law to systems to calculate the change in the center-of-mass velocity when an external force is exerted on the system. • (4.A.3.2): The student is able to use visual or mathematical representations of the forces between objects in a system to predict whether or not there will be a change in the center-of-mass velocity of that system.

Formative Assessments	Summative Assessments:	Performance Assessments:	Major Activities/ Assignments (required):
● Two Dimensional Dynamics Quiz ● Two Dimensional Dynamics Test	• Lab Write-up(s)	• Mass Lab	● Mastering Physics Online Assessments ● Any 4 of the following 6 AP approved labs which accompany this unit. Some are Open Inquiry (OI), and some are Guided Inquiry (GI) o Inertial and Gravitational Mass (GI)

Formative Assessments	Summative Assessments:	Performance Assessments:	Major Activities/ Assignments (required):
			o Forces Inventory (GI) o Static Equilibrium Challenge o Newton's Second Law (OI) o Coefficient of Friction (GI) ● Atwood's Machine (GI)

Possible Assessment Modifications /Accommodations/ Differentiation:			
Special Education	ELLs	Struggling Learners	Advanced Learners
• Clarification on questions • Fewer multiple choice • No scantron tests • Extended time for unit test on kinematics • Formatting by skill area • Read directions to student • Eliminating distractors • Corrections for unit test and quizzes • Provide study guide prior to the unit test • No penalty for spelling errors in literacy question • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• Clarification on questions • Fewer multiple choice • No Scantron tests • More picture prompts • More specific concrete questions • Extended time for unit test on forces • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis) • Read directions to student • Eliminating distractors • Retakes for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• Clarification on questions • Extended time for unit test • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis) • Eliminating distractors • Corrections for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • Calculator and equation sheet provided in class for assessments	• Corrections on unit test • Challenge question on unit test • Calculator and equation sheet provided in class for assessments

Instructional Strategies (refer to *Robert Marzano's* 41 Elements):
2.6: Identifying critical information 2.7: Organizing students to interact with new knowledge 2.8: Previewing new content 2.9: Chunking content into "digestible bites" 2.10: Processing of new information 2.11: Elaborating on new information 2.12: Recording and representing knowledge 2.13: Reflecting on learning 3.14: Reviewing content 3.15: Organizing students to practice and deepen knowledge 3.16: Using homework 3.17: Examining similarities and differences 3.18: Examining errors in reasoning 3.19: Practicing skills, strategies, and processes 3.20: Revising knowledge 4.21: Organizing students for cognitively complex tasks 4.22: Engaging students in cognitively complex tasks involving hypothesis generation and testing 4.23: Providing resources & guidance

Possible Instructional Modifications /Accommodations/Differentiation:			
Special Education	**ELLs**	**Struggling Learners**	**Advanced Learners**
• Add work areas for relationships and calculations • Highlighted key terms in questions such as: constant changing, uniform etc. • Reword questions using simpler language • Provide copy of on-line resource	• Provide computer time to work on assigned simulations during class • Provide additional work space for class and homework • Provide copy of on-line resource materials from NJCTL website • Review sessions during SMART • Add work areas for relationships	• Provide computer time to work on assigned simulations during class • Provide copy of on-line resource materials from NJCTL website • Allow extended time for balloon car and egg drop design project • Review sessions during SMART prior to unit test	• Challenge question on assessments • Hands on activities to extend learning • Calculators provided in class • Equation sheet provided in class

Possible Instructional Modifications /Accommodations/Differentiation:			
Special Education	**ELLs**	**Struggling Learners**	**Advanced Learners**
materials from NJCTL website • Additional time for projects • Review directions • Verbal and visual cues • Varied reinforcement of concepts • Concrete examples • Calculators provided in class • Equation sheet provided in class • Preferential seating	and calculations • Highlighted key terms in questions such as: constant velocity/acceleration/slowing down/no motion etc. • Reword questions using simpler language prior to unit test • Additional time for projects • Review directions • Verbal and visual cues • Varied reinforcement of concepts • Concrete examples • Graphic organizers • Calculators provided in class • Equation sheet provided in class • Preferential seating	• Calculators provided in class • Equation sheet provided in class • Preferential seating	

Unit Vocabulary:
Essential: Inertial mass, Law of Inertia, Force, Contact forces, Long-range forces, Weight, Tension, Normal force, Force of springs, Friction, Drag, Objects and systems, Force vectors, Free-body diagrams, Newton's Second Law, Newton's Third Law, Net force, Statics, Dynamics, Inclines, **Non-Essential:** Compound bodies, Agent and object, Gravity field

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
NJSLS-A-SSE.B.3 NJSLS-A-APR.B.3 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4	• Technology: Proper use of lab equipment	____ Global Awareness ____ Civic Literacy	__x__ Media Literacy __x__ Critical Thinking and Problem Solving

Interdisciplinary Connections (Applicable Standards):	**Integration of Technology:**	**21st Century Themes:**	**21st Century Skills:**
NJSLS-A-REI.A.1 NJSLS-A-REI.B.3 NJSLS-A-REI.B.4 NJSLS-A-REI.C.6 NJSLS-F-IF.B.4 NJSLS-F-IF.C.8 NJSLS-F-IF.C.9 NJSLS-F-LE.A.1 NJSLS-F-LE.A.2 NJSLS-F-TF.A. NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-G-SRT.C.7 NJSLS-G-SRT.C.8 NJSLS-G-SRT.D.11 NJSLS-S-ID.C.7 NJSLS-S-ID.C.8 NJSLS-S-ID.C.9 NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E NJSLS-W.11-12.2.A NJSLS-W.11-12.2.B NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2.A NJSLS-L.11-12.6 **Technology:**	● Mastering Physics website for additional support and practice ● Kahn Academy videos ● Proper use of Iclickers	____ Financial, Economic, Business, & Entrepreneurial Literacy ____ Health Literacy	__x__ Information & Communication Technologies Literacy __x__ Communication & Collaboration __x__ Information Literacy

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
NJSLS.8.1.12.DA.1 NJSLS.8.1.12.F.1			

Resources:
Texts/Materials: Physics, 7 ed. (Cutnell & Johnson)

Unit 3: Circular Motion and Universal Law of Gravitation	31 Days: Nov 17-Jan 12
Unit Description: This unit causes students to use concepts of straight line motion and now try to apply and adjust their prior ideas and allow them to fit the concepts of circular motion. Based on the changes in acceleration due to circular motion, students will then be led into acceleration due to gravity and then the universal law of gravitation.	

Essential Questions:	Enduring Understandings:
• Why do you stay in your seat on a roller coaster when it goes upside down in a vertical loop? • How is the motion of a falling apple similar to that of the moon in orbit around the Earth? • What conditions are necessary for a planet to obtain a circular orbit around its host star? • How can Newton's second law of motion be related to the universal law of gravitation? • How can the motion of the center of mass of a system be altered?	• Objects and systems have properties of inertial mass and gravitational mass that are experimentally verified to be the same and that satisfy conservation principles • A gravitational field is caused by an object with mass. • All forces share certain common characteristics when considered by observers in inertial references frames. • Classically, the acceleration of an object interacting with other objects can be predicted by using a=F/m. • At the macroscopic level, forces can be categorized as either long-ranged forces or contact forces. • Certain types of forces are considered fundamental. • The acceleration of the center of mass of a system is related to the net force exerted on the system, where a=F/m.

Relevant Standards:	Learning Goals:	Learning Objectives:
Content Standards: **Primary(Power):** Essential Knowledge: 1.C.3, 2.B.1, 2.B.2, 3.A.3, 3.B.1, 3.B.2, 3.C.1, 3.C.2, 3.G.1, 4.A.2 **Secondary(Supportive):** Science Practices: 6.4, 7.2, 4.2, 7.1, 2.2, 1.4,	• Understand the uniform circular motion of a particle, so they can relate the radius of the circle and the speed or rate of revolution of the particle to the magnitude of the centripetal acceleration, as well as describe the direction of the velocity or acceleration at any point in time. • Understand the uniform circular motion of a particle, so they can analyze situations in which an object moves with specified acceleration under the influence of one or more forces so they can determine the magnitude and direction of the net force, or of one of the forces that makes up the net force, in situations such as the motion in a horizontal circle (e.g., mass on a rotating merry-go-round, or car rounding a banked curve) or a vertical circle (e.g., mass swinging on the end of a string, cart rolling down a curved track, rider on a Ferris wheel). • Know Newton's Law of Universal Gravitation, so they can determine the force that one symmetrical mass exerts on another, as well as the strength of the gravitational field at a specified point outside a spherically symmetrical mass. Use this information to derive Kepler's Law.	• (1.C.3.1): The student is able to design a plan for collecting data to measure gravitational mass and to measure inertial mass, and to distinguish between the two experiments. • (2.B.1.1): The student is able to apply **F** = m**g** to calculate the gravitational force on an object with mass m in a gravitational field of strength g in the context of the effects of a net force on objects and systems. • (2.B.2.1): The student is able to apply g=G M/r^2 to calculate the gravitational field due to an object with mass M, where the field is a vector directed toward the center of the object of mass M. • (2.B.2.2): The student is able to approximate a numerical value of the gravitational field (g) near the surface of an object from its radius and mass relative to those of the Earth or other reference objects. • (3.A.3.1): The student is able to analyze a scenario and make claims (develop arguments, justify assertions) about the forces exerted on an object by other objects for different types of forces or components of forces. • (3.A.3.3): The student is able to describe a force as an interaction between two objects and identify both objects for any force. • (3.B.1.2): The student is able to design a plan to collect and analyze data for motion (static, constant, or accelerating) from force measurements and carry out an analysis to determine the relationship between the net force and the vector sum of the individual forces.

Relevant Standards:	Learning Goals:	Learning Objectives:
		• (3.B.1.3): The student is able to re-express a free-body diagram representation into a mathematical representation and solve the mathematical representation for the acceleration of the object. • (3.B.2.1): The student is able to create and use free-body diagrams to analyze physical situations to solve problems with motion qualitatively and quantitatively. • (3.C.1.1): The student is able to use Newton's law of gravitation to calculate the gravitational force the two objects exert on each other and use that force in contexts other than orbital motion. • (3.C.1.2): The student is able to use Newton's law of gravitation to calculate the gravitational force between two objects and use that force in contexts involving orbital motion (for circular orbital motion only in Physics 1). • (3.C.2.1): The student is able to use Coulomb's law qualitatively and quantitatively to make predictions about the interaction between two electric point charges (interactions between collections of electric point charges are not covered in Physics 1 and instead are restricted to Physics 2). • (3.C.2.2): The student is able to connect the concepts of gravitational force and electric force to compare similarities and differences between the forces. • (3.G.1.1): The student is able to articulate situations when the gravitational force is the dominant force and when the electromagnetic, weak, and strong forces can be ignored.

Relevant Standards:	Learning Goals:	Learning Objectives:
		• (4.A.2.2): The student is able to evaluate using given data whether all the forces on a system or whether all the parts of a system have been identified.

Formative Assessments	Summative Assessments:	Performance Assessments:	Major Activities/ Assignments (required):
• Uniform Circular Motion Quiz • Uniform Circular Motion Test • Law of Universal Gravitation Quiz • Law of Universal Gravitation Test	• Lab Write-up(s)	• Lab practical	• Mastering Physics Online Assessments • Any 2 of the following 4 AP approved labs which accompany this unit. Some are Open Inquiry (OI), and some are Guided Inquiry (GI) o Flying Toy (OI) o Galileo Ramps(GI) o Kepler Exoplanet Data (GI) o Jupiter's Moons (GI)

Possible Assessment Modifications /Accommodations/ Differentiation:			
Special Education	ELLs	Struggling Learners	Advanced Learners
• Clarification on questions • Fewer multiple choice • No Scantron tests • Extended time for unit test on kinematics • Formatting by skill area	• Clarification on questions • Fewer multiple choice • No Scantron tests • More picture prompts • More specific concrete questions	• Clarification on questions • Extended time for unit test • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis)	• Corrections on unit test • Challenge question on unit test • Calculator and equation sheet provided in class for assessments

• Read directions to student • Eliminating distractors • Corrections for unit test and quizzes • Provide study guide prior to the unit test • No penalty for spelling errors in literacy question • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• Extended time for unit test on forces • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis) • Read directions to student • Eliminating distractors • Retakes for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• Eliminating distractors • Corrections for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • Calculator and equation sheet provided in class for assessments	

Instructional Strategies (refer to *Robert Marzano's* 41 Elements):
2.6: Identifying critical information 2.7: Organizing students to interact with new knowledge 2.8: Previewing new content 2.9: Chunking content into "digestible bites" 2.10: Processing of new information 2.11: Elaborating on new information 2.12: Recording and representing knowledge 2.13: Reflecting on learning 3.14: Reviewing content 3.15: Organizing students to practice and deepen knowledge 3.16: Using homework 3.17: Examining similarities and differences 3.18: Examining errors in reasoning 3.19: Practicing skills, strategies, and processes 3.20: Revising knowledge 4.21: Organizing students for cognitively complex tasks 4.22: Engaging students in cognitively complex tasks involving hypothesis generation and testing 4.23: Providing resources & guidance

Possible Instructional Modifications /Accommodations/Differentiation:			
Special Education	ELLs	Struggling Learners	Advanced Learners
• Add work areas for relationships and calculations • Highlighted key terms in questions such as: constant changing, uniform etc. • Reword questions using simpler language • Provide copy of on-line resource materials from NJCTL website • Additional time for projects • Review directions • Verbal and visual cues	• Provide computer time to work on assigned simulations during class • Provide additional work space for class and homework • Provide copy of on-line resource materials from NJCTL website • Review sessions during SMART • Add work areas for relationships and calculations • Highlighted key terms in questions such as: constant	• Provide computer time to work on assigned simulations during class • Provide copy of on-line resource materials from NJCTL website • Allow extended time for balloon car and egg drop design project • Review sessions during SMART prior to unit test • Calculators provided in class • Equation sheet provided in class • Preferential seating	• Challenge question on assessments • Hands on activities to extend learning • Calculators provided in class • Equation sheet provided in class

Possible Instructional Modifications /Accommodations/Differentiation:			
• Varied reinforcement of concepts • Concrete examples • Calculators provided in class • Equation sheet provided in class • Preferential seating	velocity/acceleration/slowing down/no motion etc. • Reword questions using simpler language prior to unit test • Additional time for projects • Review directions • Verbal and visual cues • Varied reinforcement of concepts • Concrete examples • Graphic organizers • Calculators provided in class • Equation sheet provided in class • Preferential seating		

Unit Vocabulary:
Essential: Uniform circular motion, Period, Tangential velocity, Centripetal acceleration, Centripetal force, gravitational fields **Non-Essential:** centrifugal

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1 NJSLS-A-REI.C.6 NJSLS-F-BF.A.1 NJSLS-F-BF.A.2 NJSLS-F-TF.A.1 NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-G-SRT.C.7	**Technology:** NJSLS.8.1.12.DA.1 Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change. ● Technology: Proper use of lab equipment	____ Global Awareness ____ Civic Literacy ____ Financial, Economic, Business, & Entrepreneurial Literacy ____ Health Literacy	____ Creativity & Innovation __x__ Media Literacy __x__ Critical Thinking and Problem Solving ____ Life and Career Skills

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
NJSLS-G-SRT.C.8 NJSLS-G-SRT.D.11 NJSLS-G-C.A.4 NJSLS-S-ID.A.1 NJSLS-S-ID.A.2 NJSLS-S-ID.A.3 NJSLS-S-ID.A.4 NJSLS-S-ID.B.6 NJSLS-S-ID.C.7 NJSLS-S-ID.C.8 NJSLS-S-ID.C.9 NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E NJSLS-W.11-12.2.A NJSLS-W.11-12.2.B NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2.A NJSLS-L.11-12.6 NJSLS.8.1.12.F.1	● Mastering Physics website for additional support and practice ● Kahn Academy videos ● Proper use of Iclickers		__x__ Information & Communication Technologies Literacy __x__ Communication & Collaboration __x__ Information Literacy

Resources:
Texts/Materials: Physics, 7 ed. (Cutnell & Johnson) Leveled Reading-

Unit 4: Work, Energy, Power, and Linear Momentum	18 Days: Jan 13-Feb 6
Unit Description: This unit examines the concepts of energy and momentum. Now that students have a solid background in both forces and kinematics, we can now move into where objects get energy and are able to transfer it into any other form of energy. In this unit students will be presented with the idea that since an object has motion, and an object has mass, it has a quantity known as momentum.	

Essential Questions:	Enduring Understandings:
• 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 can changes in momentum be utilized to determine the forces applied to an object?	• A force exerted on an object can change the momentum of an object. • A force exerted on an object can change the kinetic energy of an object. • Interactions with other objects or systems can change the total linear momentum of a system . • Interactions with other objects or systems can change the total energy of the system. • Certain quantities are conserved, in the sense that the changes of those quantities in a given system are always equal to the transfer of that quantity to or from the system by all possible interactions with other systems. • The energy of a system is conserved. • The linear momentum of a system is conserved.

Relevant Standards:	Learning Goals:	Learning Objectives:
Content Standards: **Primary(Power):** Essential Knowledge: • 3.E.1, 4.C.1, 4.C.2, 5.A.2, 5.B.1, 5.B.2, 5.B.3, 5.B.4, 5.B.5, 5.D.1, 5.D.2, 3.D.1, 3.D.2, 4.B.1, 4.B.2, 5.D.3 **Secondary(Supportive):** Science Practices:	• Should understand the definition of work, including when it is positive, negative, or zero, so they can calculate the work done by a specified constant force on an object that undergoes a specified displacement, as well as understand how to calculate work done via graphical analysis. • Understand and be able to apply the work-energy theorem, so they can calculate the	• (3.D.1.1): The student is able to justify the selection of data needed to determine the relationship between the direction of the force acting on an object and the change in momentum caused by that force. • (3.D.2.1): The student is able to justify the selection of routines for the calculation of the relationships between changes in momentum of an object, average force, impulse, and time of interaction.

Relevant Standards:	Learning Goals:	Learning Objectives:
• 1.4, 2.2, 1.5, 6.4, 7.2, 5.1, 4.2, 2.1, 1.1, 7.1, 3.2, 5.3, 4.1, 4.3, 2.1	work performed by the net force, or by each of the forces that make up the net force, on an object that undergoes a specified change in mechanical energy. • Understand the concepts of mechanical energy and of total energy, so they can describe and identify situations in which mechanical energy is converted to other forms of energy or changed by friction or by a specified externally applied force. • Understand the definition of power, so they can calculate the power required to maintain the motion of an object with constant or variable velocity. • Understand impulse and linear momentum, so they can relate mass, velocity, and linear momentum for a moving object, and calculate the total linear momentum of a system of objects. • Understand linear momentum conservation, so they can apply linear momentum conservation to one-dimensional elastic and inelastic collisions and two-dimensional completely inelastic collisions.	• (3.D.2.2): The student is able to 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. • (3.D.2.3): The student is able to analyze data to characterize 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. • (3.D.2.4): The student is able to design a plan for collecting data to investigate the relationship between changes in momentum and the average force exerted on an object over time. • (3.E.1.1): The student is able to make predictions about the changes in kinetic energy of an object based on considerations of the direction of the net force on the object as the object moves. • (3.E.1.2): The student is able to use net force and velocity vectors to determine qualitatively whether kinetic energy of an object would increase, decrease, or remain unchanged. • (3.E.1.3): The student is able to use force and velocity vectors to determine qualitatively or quantitatively the net force exerted on an object and qualitatively whether kinetic energy of that object would increase, decrease, or remain unchanged. • (3.E.1.4): The student is able to apply mathematical routines to determine the change in kinetic energy of an object given the forces on the object and the displacement of the object. • (4.B.1.1): The student is able to calculate the change in linear momentum of a two-object

Relevant Standards:	Learning Goals:	Learning Objectives:
		system with constant mass in linear motion from a representation of the system (data, graphs, etc.). • (4.B.1.2): The student is able to analyze data to find the change in linear momentum for a constant-mass system using the product of the mass and the change in velocity of the center of mass. • (4.B.2.1): The student is able to apply mathematical routines to calculate the change in momentum of a system by analyzing the average force exerted over a certain time on the system. • (4.B.2.2): The student is able to perform analysis on data presented as a force-time graph and predict the change in momentum of a system. • (4.C.1.1): The student is able to calculate the total energy of a system and justify the mathematical routines used in the calculation of component types of energy within the system whose sum is the total energy. • (4.C.1.2): The student is able to predict changes in the total energy of a system due to changes in position and speed of objects or frictional interactions within the system. • (4.C.2.1): The student is able to make predictions about the changes in the mechanical energy of a system when a component of an external force acts parallel or antiparallel to the direction of the displacement of the center of mass. • (4.C.2.2): The student is able to apply the concepts of Conservation of Energy and the Work-Energy theorem to determine qualitatively and/or quantitatively that work done on a two-object system in linear motion will change the kinetic

Relevant Standards:	Learning Goals:	Learning Objectives:
		energy of the center of mass of the system, the potential energy of the systems, and/or the internal energy of the system. • (5.A.2.1): The student is able to define open and closed systems for everyday situations and apply conservation concepts for energy, charge, and linear momentum to those situations. • (5.B.1.1): The student is able to set up a representation or model showing that a single object can only have kinetic energy and use information about that object to calculate its kinetic energy. • (5.B.1.2): The student is able to translate between a representation of a single object, which can only have kinetic energy, and a system that includes the object, which may have both kinetic and potential energies. • (5.B.2.1): The student is able to calculate the expected behavior of a system using the object model (i.e., by ignoring changes in internal structure) to analyze a situation. Then, when the model fails, the student can justify the use of conservation of energy principles to calculate the change in internal energy due to changes in internal structure because the object is actually a system. • (5.B.3.1): The student is able to describe and make qualitative and/or quantitative predictions about everyday examples of systems with internal potential energy. • (5.B.3.2): The student is able to make quantitative calculations of the internal potential energy of a

Relevant Standards:	Learning Goals:	Learning Objectives:
		system from a description or diagram of that system. • (5.B.3.3): The student is able to apply mathematical reasoning to create a description of the internal potential energy of a system from a description or diagram of the objects and interactions in that system. • (5.B.4.1): The student is able to describe and make predictions about the internal energy of systems. • (5.B.4.2): The student is able to calculate changes in kinetic energy and potential energy of a system, using information from representations of that system. • (5.B.5.1): The student is able to design an experiment and analyze data to examine how a force exerted on an object or system does work on the object or system as it moves through a distance. • (5.B.5.2): The student is able to design an experiment and analyze graphical data in which interpretations of the area under a force-distance curve are needed to determine the work done on or by the object or system. • (5.B.5.3): The student is able to predict and calculate from graphical data the energy transfer to or work done on an object or system from information about a force exerted on the object or system through a distance. • (5.B.5.4): The student is able to make claims about the interaction between a system and its environment in which the environment exerts a force on the system, thus doing work on the

Relevant Standards:	Learning Goals:	Learning Objectives:
		system and changing the energy of the system (kinetic energy plus potential energy). • (5.B.5.5): The student is able to predict and calculate the energy transfer to (i.e., the work done on) an object or system from information about a force exerted on the object or system through a distance. • (5.D.1.1): The student is able to make qualitative predictions about natural phenomena based on conservation of linear momentum and restoration of kinetic energy in elastic collisions. • (5.D.1.2): The student is able to apply the principles of conservation of momentum and restoration of kinetic energy to reconcile a situation that appears to be isolated and elastic, but in which data indicate that linear momentum and kinetic energy are not the same after the interaction, by refining a scientific question to identify interactions that have not been considered. Students will be expected to solve qualitatively and/or quantitatively for one-dimensional situations and only qualitatively in two-dimensional situations. • (5.D.1.3): The student is able to apply mathematical routines appropriately to problems involving elastic collisions in one dimension and justify the selection of those mathematical routines based on conservation of momentum and restoration of kinetic energy. • (5.D.1.4): The student is able to design an experimental test of an application of the principle of the conservation of linear momentum, predict an outcome of the experiment using the principle,

Relevant Standards:	Learning Goals:	Learning Objectives:
		analyze data generated by that experiment whose uncertainties are expressed numerically, and evaluate the match between the prediction and the outcome. • (5.D.1.5): The student is able to classify a given collision situation as elastic or inelastic, justify the selection of conservation of linear momentum and restoration of kinetic energy as the appropriate principles for analyzing an elastic collision, solve for missing variables, and calculate their values. • (5.D.2.1): The student is able to qualitatively predict, in terms of linear momentum and kinetic energy, how the outcome of a collision between two objects changes depending on whether the collision is elastic or inelastic. • (5.D.2.2): The student is able to plan data collection strategies to test the law of conservation of momentum in a two-object collision that is elastic or inelastic and analyze the resulting data graphically. • (5.D.2.3): The student is able to apply the conservation of linear momentum to a closed system of objects involved in an inelastic collision to predict the change in kinetic energy. • (5.D.2.4): The student is able to analyze data that verify conservation of momentum in collisions with and without an external friction force. • (5.D.2.5): The student is able to classify a given collision situation as elastic or inelastic, justify the selection of conservation of linear momentum as the appropriate solution method for an inelastic collision, recognize that there is a common final velocity for the colliding objects in the totally

Relevant Standards:	Learning Goals:	Learning Objectives:
		inelastic case, solve for missing variables, and calculate their values. • (5.D.3.1): The student is able to predict the velocity of the center of mass of a system when there is no interaction outside of the system but there is an interaction within the system (i.e., the student simply recognizes that interactions within a system do not affect the center of mass motion of the system and is able to determine that there is no external force).

Formative Assessments	Summative Assessments:	Performance Assessments:	Major Activities/ Assignments (required):
● Work and Energy Quiz ● Work and Energy Test ● Impulse-Momentum Quiz ● Impulse-Momentum Test	• Lab Write-up(s)	• Lab practical	● Mastering Physics Online Assessments ● Any 3 of the following 7 AP approved labs which accompany this unit. Some are Open Inquiry (OI), and some are Guided Inquiry (GI) o Roller Coaster Design (OI) o Work Done Stretching a Spring (GI) o Energy and Nonconservative forces with Modified Atwood's Machine (GI) o Bumper Design(GI) o Impulse and Change in Momentum (GI) o Car Crash Physics (OI) o Forensic Investigation (GI)

Possible Assessment Modifications /Accommodations/ Differentiation:			
Special Education	ELLs	Struggling Learners	Advanced Learners
• Clarification on questions • Fewer multiple choice • No scantron tests • Extended time for unit test on kinematics • Formatting by skill area • Read directions to student • Eliminating distractors • Corrections for unit test and quizzes • Provide study guide prior to the unit test • No penalty for spelling errors in literacy question • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• Clarification on questions • Fewer multiple choice • No Scantron tests • More picture prompts • More specific concrete questions • Extended time for unit test on forces • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis) • Read directions to student • Eliminating distractors • Retakes for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• Clarification on questions • Extended time for unit test • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis) • Eliminating distractors • Corrections for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • Calculator and equation sheet provided in class for assessments	• Corrections on unit test • Challenge question on unit test • Calculator and equation sheet provided in class for assessments

Instructional Strategies (refer to *Robert Marzano's* 41 Elements):
2.6: Identifying critical information 2.7: Organizing students to interact with new knowledge 2.8: Previewing new content

2.9: Chunking content into “digestible bites”
2.10: Processing of new information
2.11: Elaborating on new information
2.12: Recording and representing knowledge
2.13: Reflecting on learning
3.14: Reviewing content
3.15: Organizing students to practice and deepen knowledge
3.16: Using homework
3.17: Examining similarities and differences
3.18: Examining errors in reasoning
3.19: Practicing skills, strategies, and processes
3.20: Revising knowledge
4.21: Organizing students for cognitively complex tasks
4.22: Engaging students in cognitively complex tasks involving hypothesis generation and testing
4.23: Providing resources & guidance

Possible Instructional Modifications /Accommodations/Differentiation:			
Special Education	ELLs	Struggling Learners	Advanced Learners
• Add work areas for relationships and calculations • Highlighted key terms in questions such as: constant changing, uniform etc. • Reword questions using simpler language • Provide copy of on-line resource materials from NJCTL website • Additional time for projects • Review directions • Verbal and visual cues • Varied reinforcement of concepts • Concrete examples • Calculators provided in class • Equation sheet provided in class	• Provide computer time to work on assigned simulations during class • Provide additional work space for class and homework • Provide copy of on-line resource materials from NJCTL website • Review sessions during SMART • Add work areas for relationships and calculations • Highlighted key terms in questions such as: constant velocity/acceleration/slowing down/no motion etc. • Reword questions using simpler language prior to unit test • Additional time for projects	• Provide computer time to work on assigned simulations during class • Provide copy of on-line resource materials from NJCTL website • Allow extended time for balloon car and egg drop design project • Review sessions during SMART prior to unit test • Calculators provided in class • Equation sheet provided in class • Preferential seating	• Challenge question on assessments • Hands on activities to extend learning • Calculators provided in class • Equation sheet provided in class

Possible Instructional Modifications /Accommodations/Differentiation:			
• Preferential seating	• Review directions • Verbal and visual cues • Varied reinforcement of concepts • Concrete examples • Graphic organizers • Calculators provided in class • Equation sheet provided in class • Preferential seating		

Unit Vocabulary:
Essential: energy, potential, kinetic, elastic, work, conservation of energy, power, impulse, momentum, elastic, inelastic, collisions, **Non-Essential:** constant, variable, explosions

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
NJSLS-A-SSE.A.1 NJSLS-A-SSE.A.2 NJSLS-A-SSE.B.3 NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1 NJSLS-A-REI.B.3 NJSLS-A-REI.B.4 NJSLS-A-REI.C.6 NJSLS-F-IF.C.8 NJSLS-F-IF.C.9 NJSLS-F-BF.A.1 NJSLS-F-BF.A.2 NJSLS-F-BF.B.4 NJSLS-F-BF.B.5	• Technology: Proper use of lab equipment • Mastering Physics website for additional support and practice • Kahn Academy videos • Proper use of Iclickers	____ Global Awareness ____ Civic Literacy ____ Financial, Economic, Business, & Entrepreneurial Literacy ____ Health Literacy	__x__ Media Literacy __x__ Critical Thinking and Problem Solving __x__ Information & Communication Technologies Literacy __x__ Communication & Collaboration __x__ Information Literacy

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
NJSLS-F-LE.A.1 NJSLS-F-LE.A.2 NJSLS-F-TF.A.1 NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-F-TF.B.5 NJSLS-F-TF.B.7 NJSLS-G-SRT.D.11 NJSLS-S-ID.B.6 NJSLS-S-ID.C.7 NJSLS-S-ID.C.8 NJSLS-S-ID.C NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E NJSLS-W.11-12.2.A NJSLS-W.11-12.2.B NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2.A NJSLS-L.11-12.6 **Technology:** NJSLS.8.1.12.DA.1 NJSLS.8.1.12.F.1			

Resources:
Texts/Materials: Physics, 7 ed. (Cutnell & Johnson) Leveled Reading-

Unit 5: Torque and Rotational Motion	13 Days: Feb 9-27
Unit Description: This unit describes that torque is a force produced on some rigid body. Students will learn how to describe, explain, and predict the motion of an object that is rotating based on the torque produced on it.	

Essential Questions:	Enduring Understandings:
• What are the conditions necessary for two people with significant differences in mass to balance on a seesaw? • What are the conditions necessary for static equilibrium? • In what ways are rotational motion and linear motion related? • What are the relationships among angular momentum, angular velocity, angular acceleration, rotational inertia, and torque?	• A force exerted on an object can cause a torque on that object. • The acceleration of the center of mass of a system is related to the net force exerted on the system, where a=F/m. • A net torque exerted on a system by other objects or systems will change the angular momentum of the system. • The angular momentum of a system is conserved.

Relevant Standards:	Learning Goals:	Learning Objectives:
Content Standards: • **Primary(Power):** Essential Knowledge: • 3.F.1, 3.F.2, 3.F.3, 4.A.1, 4.D.1, 4.D.2, 4.D.3, 5.E.1, 5.E.2 • **Secondary(Supportive):** Science Practices: • 1.4, 2.3, 4.1, 4.2, 5.1, 2.2, 5.3, 1.2, 6.4, 3.2, 7.2	• Understand the concept of torque, so they can calculate the magnitude and direction of the torque associated with a given force. • Analyze problems in statics, so they can state the conditions for translational and rotational equilibrium of a rigid object. • Understand the definition and applications of angular momentum including its relationship to torque. • Understand that contact between rolling objects and what they roll against imposes constraints on the change in position (velocity) and angle (angular velocity).	• (3.F.1.1): The student is able to use representations of the relationship between force and torque. • (3.F.1.2): The student is able to compare the torques on an object caused by various forces. • (3.F.1.3): The student is able to estimate the torque on an object caused by various forces in comparison to other situations. • (3.F.1.4): The student is able to design an experiment and analyze data testing a question about torques in a balanced rigid system. • (3.F.1.5): The student is able to calculate torques on a two-dimensional system in static equilibrium, by examining a representation or model (such as a diagram or physical construction). • (3.F.2.1): The student is able to make predictions about the change in the angular velocity about an axis for an object when forces exerted on the object cause a torque about that axis.

Relevant Standards:	Learning Goals:	Learning Objectives:
		• (3.F.2.2): The student is able to plan data collection and analysis strategies designed to test the relationship between a torque exerted on an object and the change in angular velocity of that object about an axis. • (3.F.3.1): The student is able to predict the behavior of rotational collision situations by the same processes that are used to analyze linear collision situations using an analogy between impulse and change of linear momentum and angular impulse and change of angular momentum. • (3.F.3.2): In an unfamiliar context or using representations beyond equations, the student is able to justify the selection of a mathematical routine to solve for the change in angular momentum of an object caused by torques exerted on the object • (3.F.3.3): The student is able to plan data collection and analysis strategies designed to test the relationship between torques exerted on an object and the change in angular momentum of that object. • (4.A.1.1): The student is able to use representations of the center of mass of an isolated two-object system to analyze the motion of the system qualitatively and semi-quantitatively. • (4.D.1.1): The student is able to describe a representation and use it to analyze a situation in which several forces exerted on a rotating system of rigidly connected objects change the angular velocity and angular momentum of the system.

Relevant Standards:	Learning Goals:	Learning Objectives:
		• (4.D.1.2): The student is able to plan data collection strategies designed to establish that torque, angular velocity, angular acceleration, and angular momentum can be predicted accurately when the variables are treated as being clockwise or counterclockwise with respect to a well-defined axis of rotation, and refine the research question based on the examination of data. • (4.D.2.1): The student is able to describe a model of a rotational system and use that model to analyze a situation in which angular momentum changes due to interaction with other objects or systems. • (4.D.2.2): The student is able to plan a data collection and analysis strategy to determine the change in angular momentum of a system and relate it to interactions with other objects and systems. • (4.D.3.1): The student is able to use appropriate mathematical routines to calculate values for initial or final angular momentum, or change in angular momentum of a system, or average torque or time during which the torque is exerted in analyzing a situation involving torque and angular momentum. • (4.D.3.2): The student is able to plan a data collection strategy designed to test the relationship between the change in angular momentum of a system and the product of the average torque applied to the system and the time interval during which the torque is exerted. • (5.E.1.1): The student is able to make qualitative predictions about the angular momentum of a

Relevant Standards:	Learning Goals:	Learning Objectives:
		system for a situation in which there is no net external torque. • (5.E.1.2): The student is able to make calculations of quantities related to the angular momentum of a system when the net external torque on the system is zero. • (5.E.2.1): The student is able to describe or calculate the angular momentum and rotational inertia of a system in terms of the locations and velocities of objects that make up the system. Students are expected to do qualitative reasoning with compound objects. Students are expected to do calculations with a fixed set of extended objects and point masses.

Formative Assessments	Summative Assessments:	Performance Assessments:	Major Activities/ Assignments (required):
• Rotational Motion Quiz • Rotational Motion Test	• Lab Write-up(s)	• Lab practical	• MasteringPhysics Online Assessments • Any 2 of the following 5 AP approved labs which accompany this unit. Some are Open Inquiry (OI), and some are Guided Inquiry (GI) o Torque and the Human Arm (OI) o Rotational Inertia (GI) o Conservation of Angular Momentum (GI) o Rolling Cylinders (OI) o Torque Simulation (GI)

Possible Assessment Modifications /Accommodations/ Differentiation:			
Special Education	**ELLs**	**Struggling Learners**	**Advanced Learners**
• Clarification on questions • Fewer multiple choice • No scantron tests • Extended time for unit test on kinematics • Formatting by skill area • Read directions to student • Eliminating distractors • Corrections for unit test and quizzes • Provide study guide prior to the unit test • No penalty for spelling errors in literacy question • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• Clarification on questions • Fewer multiple choice • No Scantron tests • More picture prompts • More specific concrete questions • Extended time for unit test on forces • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis) • Read directions to student • Eliminating distractors • Retakes for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• Clarification on questions • Extended time for unit test • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis) • Eliminating distractors • Corrections for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • Calculator and equation sheet provided in class for assessments	• Corrections on unit test • Challenge question on unit test • Calculator and equation sheet provided in class for assessments

Instructional Strategies (refer to *Robert Marzano's* 41 Elements):
2.6: Identifying critical information 2.7: Organizing students to interact with new knowledge 2.8: Previewing new content 2.9: Chunking content into "digestible bites" 2.10: Processing of new information

Instructional Strategies (refer to *Robert Marzano's* 41 Elements):
2.11: Elaborating on new information 2.12: Recording and representing knowledge 2.13: Reflecting on learning 3.14: Reviewing content 3.15: Organizing students to practice and deepen knowledge 3.16: Using homework 3.17: Examining similarities and differences 3.18: Examining errors in reasoning 3.19: Practicing skills, strategies, and processes 3.20: Revising knowledge 4.21: Organizing students for cognitively complex tasks 4.22: Engaging students in cognitively complex tasks involving hypothesis generation and testing 4.23: Providing resources & guidance

Possible Instructional Modifications /Accommodations/Differentiation:			
Special Education	**ELLs**	**Struggling Learners**	**Advanced Learners**
• Add work areas for relationships and calculations • Highlighted key terms in questions such as: constant changing, uniform etc. • Reword questions using simpler language • Provide copy of on-line resource materials from NJCTL website • Additional time for projects • Review directions • Verbal and visual cues • Varied reinforcement of concepts • Concrete examples	• Provide computer time to work on assigned simulations during class • Provide additional work space for class and homework • Provide copy of on-line resource materials from NJCTL website • Review sessions during SMART • Add work areas for relationships and calculations • Highlighted key terms in questions such as: constant velocity/acceleration/slowing down/no motion etc. • Reword questions using simpler language prior to unit test	• Provide computer time to work on assigned simulations during class • Provide copy of on-line resource materials from NJCTL website • Allow extended time for balloon car and egg drop design project • Review sessions during SMART prior to unit test • Calculators provided in class • Equation sheet provided in class • Preferential seating	• Challenge question on assessments • Hands on activities to extend learning • Calculators provided in class • Equation sheet provided in class

Possible Instructional Modifications /Accommodations/Differentiation:			
• Calculators provided in class • Equation sheet provided in class • Preferential seating	• Additional time for projects • Review directions • Verbal and visual cues • Varied reinforcement of concepts • Concrete examples • Graphic organizers • Calculators provided in class • Equation sheet provided in class • Preferential seating		

Unit Vocabulary:
Essential: center of mass, rotational, angular, torque, angular displacement, angular acceleration, angular velocity, angular momentum, simple machines, **Non-Essential:** cross product

Interdisciplinary Connections (Applicable Standards):	**Integration of Technology:**	**21st Century Themes:**	**21st Century Skills:**
NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1 NJSLS-A-REI.C.6 NJSLS-F-BF.A.1 NJSLS-F-BF.A.2 NJSLS-F-TF.A.1 NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-G-SRT.C.7 NJSLS-G-SRT.C.8 NJSLS-G-SRT.D.11 NJSLS-G-C.A.4 NJSLS-S-ID.A.1 NJSLS-S-ID.A.2	• Technology: Proper use of lab equipment • Mastering Physics website for additional support and practice • Kahn Academy videos • Proper use of Iclickers	____ Global Awareness ____ Civic Literacy ____ Financial, Economic, Business, & Entrepreneurial Literacy ____ Health Literacy	__x__ Media Literacy __x__ Critical Thinking and Problem Solving __x__ Information & Communication Technologies Literacy __x__ Communication & Collaboration __x__ Information Literacy

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
NJSLS-S-ID.A.3 NJSLS-S-ID.A.4 NJSLS-S-ID.B.6 NJSLS-S-ID.C.7 NJSLS-S-ID.C.8 NJSLS-S-ID.C.9 NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E NJSLS-W.11-12.2.A NJSLS-W.11-12.2.B NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2.A NJSLS-L.11-12.6 **Technology:** NJSLS.8.1.12.DA.1 NJSLS.8.1.12.F.1			

Resources:
Texts/Materials: Physics, 7 ed. (Cutnell & Johnson) Leveled Reading-

Unit 6: Simple Harmonic motion, Waves, and Sound	13 Days: Mar 2-18
Unit Description: In this unit we will cover vibrational motion and how these vibrations occur when a system is disturbed from its equilibrium position, moves back toward equilibrium, and then overshoots it. The cause of this is a restoring force that constantly causes the system to want to return to equilibrium. This is the concept of simple harmonic motion and can then lead to both mechanical waves and sound waves.	

Essential Questions:	Enduring Understandings:
• What properties determine the motion of an object in simple harmonic motion? • What exactly is a wave, and what are the various methods for creating one? • What are the relationships between velocity, wavelength, and frequency of a wave? • How do the relative motions of source and observer determine our perceptions of waves? • What happens when two or more waves meet?	• Classically, the acceleration of an object interacting with other objects can be predicted by using a=F/m. • The energy of a system is conserved. • A wave is a traveling disturbance that transfers energy and momentum. • A periodic wave is one that repeats as a function of both time and position and can be described by its amplitude, frequency, wavelength, speed, and energy. • Interference and superposition lead to standing waves and beats.

Relevant Standards:	Learning Goals:	Learning Objectives:
Content Standards: **Primary(Power):** Essential Knowledge: • 3.B.3, 5.B.2, 5.B.3, 5.B.4, 6.A.1, 6.A.2, 6.A.3, 6.A.4, 6.B.1, 6.B.2, 6.B.4, 6.B.5, 6.D.1, 6.D.2, 6.D.3, 6.D.4, 6.D.5 **Secondary(Supportive):** Science Practices: • 6.4, 7.2, 4.2, 2.2, 5.1, 6.2, 1.2, 1.4, 2.1, 3.2, 5.2, 5.3, 1.5, 6.1	• Understand simple harmonic motion, so they can sketch or identify a graph of displacement as a function of time, and determine from such a graph the amplitude, period, and frequency of the motion, as well as state the relations between acceleration, velocity, and displacement, and identify points in the motion where these quantities are zero or achieve their greatest positive and negative values. • Understand simple harmonic motion, so they can state how the total energy of an	• (3.B.3.1): The student is able to predict which properties determine the motion of a simple harmonic oscillator and what the dependence of the motion is on those properties. • (3.B.3.2): The student is able to design a plan and collect data in order to ascertain the characteristics of the motion of a system undergoing oscillatory motion caused by a restoring force. • (3.B.3.3): The student can analyze data to identify qualitative or quantitative relationships between given values and variables (i.e., force, displacement, acceleration, velocity, period of

Relevant Standards:	Learning Goals:	Learning Objectives:
	oscillating system depends on the amplitude of the motion, sketch or identify a graph of these quantities, while proving that the sum of these quantities is constant. • Understand the description of traveling waves, so they can sketch or identify graphs that represent traveling waves and determine the amplitude, wavelength, and frequency of a wave from such a graph. • Understand the description of traveling waves, so they can describe reflection of a wave from the fixed or free end of a string. • Understand the physics of standing waves, so they can sketch possible standing wave modes for a stretched string that is fixed at both ends, or a sound wave in a pipe with either open or closed ends, then determine the amplitude, wavelength, and frequency of such standing waves. • Understand the principle of superposition, so they can apply it to traveling waves moving in opposite directions, and describe how a standing wave may be formed by superposition. • Understand the interference and diffraction of waves, and how it can affect individual variables relating to waves.	motion, frequency, spring constant, string length, mass) associated with objects in oscillatory motion to use that data to determine the value of an unknown. • (3.B.3.4): The student is able to construct a qualitative and/or a quantitative explanation of oscillatory behavior given evidence of a restoring force. • (5.B.2.1): The student is able to calculate the expected behavior of a system using the object model (i.e., by ignoring changes in internal structure) to analyze a situation. Then, when the model fails, the student can justify the use of conservation of energy principles to calculate the change in internal energy due to changes in internal structure because the object is actually a system. • (5.B.3.1): The student is able to describe and make qualitative and/or quantitative predictions about everyday examples of systems with internal potential energy. • (5.B.3.2): The student is able to make quantitative calculations of the internal potential energy of a system from a description or diagram of that system. • (5.B.3.3): The student is able to apply mathematical reasoning to create a description of the internal potential energy of a system from a description or diagram of the objects and interactions in that system. • (5.B.4.1): The student is able to describe and make predictions about the internal energy of systems.

Relevant Standards:	Learning Goals:	Learning Objectives:
		• (5.B.4.2): The student is able to calculate changes in kinetic energy and potential energy of a system, using information from representations of that system. • (6.A.1.1): The student is able to use a visual representation to construct an explanation of the distinction between transverse and longitudinal waves by focusing on the vibration that generates the wave. • (6.A.1.2): The student is able to describe representations of transverse and longitudinal waves. • (6.A.1.3): The student is able to analyze data to identify patterns that indicate that a particular wave is polarized and construct an explanation of the fact that the wave must have a vibration perpendicular to the direction of energy propagation • (6.A.2.1): The student is able to describe sound in terms of transfer of energy and momentum in a medium and relate the concepts to everyday examples. • (6.A.3.1): The student is able to use graphical representations of a periodic mechanical wave to determine the amplitude of the wave. • (6.A.4.1): The student is able to explain and/or predict qualitatively how the energy carried by a sound wave relates to the amplitude of the wave, and/or apply this concept to a real-world example. • (6.B.1.1): The student is able to use a graphical representation of a periodic mechanical wave (position versus time) to determine the period and frequency of the wave and describe how a change

Relevant Standards:	Learning Goals:	Learning Objectives:
		in the frequency would modify features of the representation. • (6.B.2.1): The student is able to use a visual representation of a periodic mechanical wave to determine wavelength of the wave. • (6.B.4.1): The student is able to design an experiment to determine the relationship between periodic wave speed, wavelength, and frequency and relate these concepts to everyday examples. • (6.B.5.1): The student is able to create or use a wave front diagram to demonstrate or interpret qualitatively the observed frequency of a wave, dependent upon relative motions of source and observer. • (6.D.1.1): The student is able to use representations of individual pulses and construct representations to model the interaction of two wave pulses to analyze the superposition of two pulses. • (6.D.1.2): The student is able to design a suitable experiment and analyze data illustrating the superposition of mechanical waves (only for wave pulses or standing waves). • (6.D.1.3): The student is able to design a plan for collecting data to quantify the amplitude variations when two or more traveling waves or wave pulses interact in a given medium. • (6.D.2.1): The student is able to analyze data or observations or evaluate evidence of the interaction of two or more traveling waves in one or two dimensions (i.e., circular wave fronts) to evaluate the variations in resultant amplitudes.

Relevant Standards:	Learning Goals:	Learning Objectives:
		• (6.D.3.1): The student is able to refine a scientific question related to standing waves and design a detailed plan for the experiment that can be conducted to examine the phenomenon qualitatively or quantitatively. • (6.D.3.2): The student is able to predict properties of standing waves that result from the addition of incident and reflected waves that are confined to a region and have nodes and antinodes. • (6.D.3.3): The student is able to plan data collection strategies, predict the outcome based on the relationship under test, perform data analysis, evaluate evidence compared to the prediction, explain any discrepancy and, if necessary, revise the relationship among variables responsible for establishing standing waves on a string or in a column of air. • (6.D.3.4): The student is able to describe representations and models of situations in which standing waves result from the addition of incident and reflected waves confined to a region. • (6.D.4.1): The student is able to challenge with evidence the claim that the wavelengths of standing waves are determined by the frequency of the source regardless of the size of the region. • (6.D.4.2): The student is able to calculate wavelengths and frequencies (if given wave speed) of standing waves based on boundary conditions and length of region within which the wave is confined, and calculate numerical values of wavelengths and frequencies. Examples should include musical instruments.

Relevant Standards:	Learning Goals:	Learning Objectives:
		• (6.D.5.1): The student is able to use a visual representation to explain how waves of slightly different frequency give rise to the phenomenon of beats.

Formative Assessments	Summative Assessments:	Performance Assessments:	Major Activities/ Assignments (required):
• Simple Harmonic Motion Quiz • Simple Harmonic Motion Test • Sound and Waves Quiz • Sound and Waves Test	• Lab Write-up(s)	• Lab practical	• MasteringPhysics Online Assessments • Any 2 of the following 5 AP approved labs which accompany this unit. Some are Open Inquiry (OI), and some are Guided Inquiry (GI) o Resonance Apparatus Lab (GI) o Beats and Standing Waves (GI) o Speed of Sound (OI) o Wave Boundary Behavior (GI) o Standing Sound Waves in a Tube (OI)

Possible Assessment Modifications /Accommodations/ Differentiation:			
Special Education	**ELLs**	**Struggling Learners**	**Advanced Learners**
• Clarification on questions • Fewer multiple choice • No scantron tests • Extended time for unit test on kinematics	• Clarification on questions • Fewer multiple choice • No Scantron tests • More picture prompts • More specific concrete questions	• Clarification on questions • Extended time for unit test • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for	• Corrections on unit test • Challenge question on unit test • Calculator and equation sheet provided in class for assessments

• Formatting by skill area • Read directions to student • Eliminating distractors • Corrections for unit test and quizzes • Provide study guide prior to the unit test • No penalty for spelling errors in literacy question • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• Extended time for unit test on forces • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis) • Read directions to student • Eliminating distractors • Retakes for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	emphasis) • Eliminating distractors • Corrections for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • Calculator and equation sheet provided in class for assessments	

Instructional Strategies (refer to *Robert Marzano's* 41 Elements):
2.6: Identifying critical information 2.7: Organizing students to interact with new knowledge 2.8: Previewing new content 2.9: Chunking content into "digestible bites" 2.10: Processing of new information 2.11: Elaborating on new information 2.12: Recording and representing knowledge 2.13: Reflecting on learning 3.14: Reviewing content 3.15: Organizing students to practice and deepen knowledge 3.16: Using homework 3.17: Examining similarities and differences 3.18: Examining errors in reasoning 3.19: Practicing skills, strategies, and processes 3.20: Revising knowledge

4.21: Organizing students for cognitively complex tasks
4.22: Engaging students in cognitively complex tasks involving hypothesis generation and testing
4.23: Providing resources & guidance

Possible Instructional Modifications /Accommodations/Differentiation:			
Special Education	**ELLs**	**Struggling Learners**	**Advanced Learners**
• Add work areas for relationships and calculations • Highlighted key terms in questions such as: constant changing, uniform etc. • Reword questions using simpler language • Provide copy of on-line resource materials from NJCTL website • Additional time for projects • Review directions • Verbal and visual cues • Varied reinforcement of concepts • Concrete examples • Calculators provided in class • Equation sheet provided in class • Preferential seating	• Provide computer time to work on assigned simulations during class • Provide additional work space for class and homework • Provide copy of on-line resource materials from NJCTL website • Review sessions during SMART • Add work areas for relationships and calculations • Highlighted key terms in questions such as: constant velocity/acceleration/slowing down/no motion etc. • Reword questions using simpler language prior to unit test • Additional time for projects • Review directions • Verbal and visual cues • Varied reinforcement of concepts • Concrete examples • Graphic organizers • Calculators provided in class • Equation sheet provided in class • Preferential seating	• Provide computer time to work on assigned simulations during class • Provide copy of on-line resource materials from NJCTL website • Allow extended time for balloon car and egg drop design project • Review sessions during SMART prior to unit test • Calculators provided in class • Equation sheet provided in class • Preferential seating	• Challenge question on assessments • Hands on activities to extend learning • Calculators provided in class • Equation sheet provided in class

Unit Vocabulary:
Essential: Hooke's law, equilibrium, period, frequency, wavelength, amplitude, medium, orbital, interference, superposition, reflection, resonance, Doppler effect, beats **Non-Essential:** spring, pendulum

Interdisciplinary Connections (Applicable Standards):	**Integration of Technology:**	**21st Century Themes:**	**21st Century Skills:**
NJSLS Mathematics: NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1 NJSLS-A-REI.C.6 NJSLS-F-IF.A.1 NJSLS-F-IF.A.2 NJSLS-F-IF.A.3 NJSLS-F-IF.B.4 NJSLS-F-IF.C.8 NJSLS-F-IF.C.9 NJSLS-F-TF.A.1 NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-F-TF.B.5 NJSLS-F-TF.B.7 NJSLS-S-ID.B.6 NJSLS-S-ID.C.7 NJSLS-S-ID.C.8 NJSLS-S-ID.C.9 **NJSLS ELA Literacy:** NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E	● Technology: Proper use of lab equipment ● Mastering Physics website for additional support and practice ● Kahn Academy videos ● Proper use of Iclickers	____ Global Awareness ____ Civic Literacy ____ Financial, Economic, Business, & Entrepreneurial Literacy ____ Health Literacy	__x__ Media Literacy __x__ Critical Thinking and Problem Solving __x__ Information & Communication Technologies Literacy __x__ Communication & Collaboration __x__ Information Literacy

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
NJSLS-W.11-12.2.A NJSLS-W.11-12.2.B NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2.A NJSLS-L.11-12.6 **Technology:** NJSLS.8.1.12.DA.1 NJSLS.8.1.12.F.1			

Resources:
Texts/Materials: Physics, 7 ed. (Cutnell & Johnson) Leveled Reading-

Unit 7: Electrostatics and Simple Electric Circuits	7 Days: Mar 18-27
Unit Description: In this unit we will describe electrostatic interactions when a force is exerted on one charge by another, and with electric potential energy. We will also explain the process involved in charging particles and relate this to DC circuits in everyday objects.	

Essential Questions:	Enduring Understandings:
• What is lightning, and why is it so dangerous? • What are the fundamental carriers of electrical charge, and how may they be used to charge objects? • How is gravitational force similar to electrical force, and in what ways are these forces very different? • How are voltage, current, and resistance related in a series circuit?	• Electric charge is a property of an object or system that affects its interactions with other objects or systems containing charge. • Materials have many macroscopic properties that result from the arrangement and interactions of the atoms and molecules that make up the material. • At the macroscopic level, forces can be categorized as either long-range forces or contact forces.

Essential Questions:	Enduring Understandings:
• How are voltage, current, and resistance related in a simple parallel circuit?	• Certain quantities are conserved, in the sense that the changes of those quantities in a given system are always equal to the transfer of that quantity to or from the system by all possible interactions with other systems. • The energy of a system is conserved. • The electric charge of a system is conserved.

Relevant Standards:	Learning Goals:	Learning Objectives:
Content Standards: **Primary(Power):** Essential Knowledge: • 1.B.1, 1.B.2, 1.B.3, 3.C.2, 5.A.2, 1.E.2, 5.B.9, 5.C.3 **Secondary(Supportive):** Science Practices: • 6.4, 7.2, 6.1, 6.2, 2.2, 4.2, 4.1, 5.1, 1.4, 1.1	• Understand the concept of electric charge and electric fields, so they can describe the types of charge and the attraction and repulsion of charges, as well as calculate any resulting forces on test or point charges. • Understand the definition of electric current, so they can relate the magnitude and direction of the current to the rate of flow of positive and negative charge. • Apply Ohm's law to direct-current circuits, in order to determine a single unknown current, voltage, or resistance.	• (1.B.1.1): The student is able to make claims about natural phenomena based on conservation of electric charge. • (1.B.1.2): The student is able to make predictions, using the conservation of electric charge, about the sign and relative quantity of net charge of objects or systems after various charging processes, including conservation of charge in simple circuits. • (1.B.2.1): The student is able to construct an explanation of the two-charge model of electric charge based on evidence produced through scientific practices. • (1.B.3.1): The student is able to challenge the claim that an electric charge smaller than the elementary charge has been isolated. • (1.E.2.1): The student is able to choose and justify the selection of data needed to determine resistivity for a given material. • (3.C.2.1): The student is able to use Coulomb's law qualitatively and quantitatively to make predictions about the interaction between two electric point charges (interactions between collections of

Relevant Standards:	Learning Goals:	Learning Objectives:
		electric point charges are not covered in Physics 1 and instead are restricted to Physics 2). • (3.C.2.2): The student is able to connect the concepts of gravitational force and electric force to compare similarities and differences between the forces. • (5.A.2.1): The student is able to define open and closed systems for everyday situations and apply conservation concepts for energy, charge, and linear momentum to those situations. • (5.B.9.1): The student is able to construct or interpret a graph of the energy changes within an electrical circuit with only a single battery and resistors in series and/or in, at most, one parallel branch as an application of the conservation of energy (Kirchhoff's loop rule). • (5.B.9.2): The student is able to apply conservation of energy concepts to the design of an experiment that will demonstrate the validity of Kirchhoff's loop rule in a circuit with only a battery and resistor either in series or in, at most, one pair of parallel branches. • (5.B.9.3): The student is able to apply conservation of energy (Kirchhoff's loop rule) in calculations involving the total electric potential difference for complete circuit loops with only a single battery and resistors in series and/or in, at most, one parallel branch. • (5.C.3.1): The student is able to apply conservation of electric charge (Kirchhoff's junction rule) to the comparison of electric current in various segments of an electrical circuit with a single battery and resistors in series and in, at most, one parallel

Relevant Standards:	Learning Goals:	Learning Objectives:
		branch and predict how those values would change if configurations of the circuit are changed. • (5.C.3.2): The student is able to design an investigation of an electrical circuit with one or more resistors in which evidence of conservation of electric charge can be collected and analyzed. • (5.C.3.3): The student is able to use a description or schematic diagram of an electrical circuit to calculate unknown values of current in various segments or branches of the circuit.

Formative Assessments	Summative Assessments:	Performance Assessments:	Major Activities/ Assignments (required):
• Electrostatics Quiz • Circuits Quiz • Electrostatics/Circuits Test	• Lab Write-up(s)	• Lab practical	• MasteringPhysics Online Assessments • Any 1 of the following 4 AP approved labs which accompany this unit. Some are Open Inquiry (OI), and some are Guided Inquiry (GI) o Coulomb's Law (GI) o Static Electricity Interactions (OI) o Brightness Investigation (OI) o Series and Parallel Circuits (GI)

Possible Assessment Modifications /Accommodations/ Differentiation:			
Special Education	**ELLs**	**Struggling Learners**	**Advanced Learners**
• Clarification on questions • Fewer multiple choice	• Clarification on questions • Fewer multiple choice	• Clarification on questions • Extended time for unit test	• Corrections on unit test • Challenge question on unit

• No scantron tests • Extended time for unit test on kinematics • Formatting by skill area • Read directions to student • Eliminating distractors • Corrections for unit test and quizzes • Provide study guide prior to the unit test • No penalty for spelling errors in literacy question • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• No Scantron tests • More picture prompts • More specific concrete questions • Extended time for unit test on forces • Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis) • Read directions to student • Eliminating distractors • Retakes for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • No penalty for significant figure errors • Calculator and equation sheet provided in class for assessments	• Chunking questions/choices • Formatting (Enlarge font/increase spacing/make font bold for emphasis) • Eliminating distractors • Corrections for unit test • Provide study guide prior to the unit test • No penalty for spelling errors • Calculator and equation sheet provided in class for assessments	test • Calculator and equation sheet provided in class for assessments

Instructional Strategies (refer to *Robert Marzano's* 41 Elements):
2.6: Identifying critical information 2.7: Organizing students to interact with new knowledge 2.8: Previewing new content 2.9: Chunking content into "digestible bites" 2.10: Processing of new information 2.11: Elaborating on new information 2.12: Recording and representing knowledge 2.13: Reflecting on learning 3.14: Reviewing content 3.15: Organizing students to practice and deepen knowledge

3.16: Using homework
3.17: Examining similarities and differences
3.18: Examining errors in reasoning
3.19: Practicing skills, strategies, and processes
3.20: Revising knowledge
4.21: Organizing students for cognitively complex tasks
4.22: Engaging students in cognitively complex tasks involving hypothesis generation and testing
4.23: Providing resources & guidance

Possible Instructional Modifications /Accommodations/Differentiation:			
Special Education	**ELLs**	**Struggling Learners**	**Advanced Learners**
• Add work areas for relationships and calculations • Highlighted key terms in questions such as: constant changing, uniform etc. • Reword questions using simpler language • Provide copy of on-line resource materials from NJCTL website • Additional time for projects • Review directions • Verbal and visual cues • Varied reinforcement of concepts • Concrete examples • Calculators provided in class • Equation sheet provided in class • Preferential seating	• Provide computer time to work on assigned simulations during class • Provide additional work space for class and homework • Provide copy of on-line resource materials from NJCTL website • Review sessions during SMART • Add work areas for relationships and calculations • Highlighted key terms in questions such as: constant velocity/acceleration/slowing down/no motion etc. • Reword questions using simpler language prior to unit test • Additional time for projects • Review directions • Verbal and visual cues • Varied reinforcement of concepts • Concrete examples • Graphic organizers • Calculators provided in class	• Provide computer time to work on assigned simulations during class • Provide copy of on-line resource materials from NJCTL website • Allow extended time for balloon car and egg drop design project • Review sessions during SMART prior to unit test • Calculators provided in class • Equation sheet provided in class • Preferential seating	• Challenge question on assessments • Hands on activities to extend learning • Calculators provided in class • Equation sheet provided in class

Possible Instructional Modifications /Accommodations/Differentiation:			
	• Equation sheet provided in class • Preferential seating		

Unit Vocabulary:
Essential: Charge, Electric field, Electric force, Conductors, insulators, Conservation of charge, Conduction, Induction, Current, batteries, EMF, Resistance, Ohm's Law, Power, Kirchhoff's Laws, DC, resistor, circuits **Non-Essential:** charging

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
NJSLS Math: NJSLS-A-CED.A.1 NJSLS-A-CED.A.2 NJSLS-A-CED.A.4 NJSLS-A-REI.A.1 NJSLS-F-LE.A.1 NJSLS-F-LE.A.2 NJSLS-F-TF.A.1 NJSLS-F-TF.A.2 NJSLS-F-TF.A.4 NJSLS-F-TF.B.5 NJSLS-F-TF.B.7 NJSLS-G-SRT.C.7 NJSLS-G-SRT.C.8 NJSLS-G-SRT.D.11 NJSLS-S-ID.A.1 NJSLS-S-ID.A.2 NJSLS-S-ID.A.3 NJSLS-S-ID.A.4 NJSLS-S-ID.B.6 **NJSLS ELA Literacy:**	**Technology:** • Technology: Proper use of lab equipment • Mastering Physics website for additional support and practice • Kahn Academy videos • Proper use of Iclickers	____ Global Awareness ____ Civic Literacy ____ Financial, Economic, Business, & Entrepreneurial Literacy ____ Health Literacy	__x__ Media Literacy __x__ Critical Thinking and Problem Solving __x__ Information & Communication Technologies Literacy __x__ Communication & Collaboration __x__ Information Literacy

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
NJSLS-RI.11-12.7 NJSLS-W.11-12.1.A NJSLS-W.11-12.1.D NJSLS-W.11-12.1.E NJSLS-W.11-12.2.A NJSLS-W.11-12.2.B NJSLS-W.11-12.4 NJSLS-W.11-12.6 NJSLS-W.11-12.7 NJSLS-SL.11-12.4 NJSLS-SL.11-12.5 NJSLS-L.11-12.1.A NJSLS-L.11-12.2.A NJSLS-L.11-12.6 NJSLS.8.1.12.DA.1 NJSLS.8.1.12.F.1			

Resources:
Texts/Materials: Physics, 7 ed. (Cutnell & Johnson) Leveled Reading-