FREEHOLD REGIONAL HIGH SCHOOL DISTRICT

OFFICE OF CURRICULUM AND INSTRUCTION

MEDICAL SCIENCES

AP PHYSICS B

Grade Level: 12

Credits: 5

BOARD OF EDUCATION ADOPTION DATE:

AUGUST 30, 2010

SUPPORTING RESOURCES AVAILABLE IN DISTRICT RESOURCE SHARING
APPENDIX A: ACCOMMODATIONS AND MODIFICATIONS
APPENDIX B: ASSESSMENT EVIDENCE
APPENDIX C: INTERDISCIPLINARY CONNECTIONS

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Course Philosophy

Physics is a science which attempts to understand the universe around us, its past, present and future. It is the intent of this course to equip the high school physics students with a conceptual and mathematical base of physical knowledge. From this base they can predict, control, calculate, derive, measure, and observe their interactions with the physical world around them on a daily basis. This base will also foster their critical and analytical thinking for use throughout their lifetime. This course will emphasize learning the fundamental principles of nature from which concepts can be derived as well as delve more deeply within particular topics. The philosophy of this course is based on providing the student with an inquiry-based foundation in physics which will prepare students to interact with and understand the world around them. The basic principles and ideas of physics, if understood, are what students will use for the rest of their lives by applying them to countless real life situations. It is the goal of Medical Science AP Physics B to facilitate students' understanding of the rules of nature by learning their foundations, in addition to learning their mathematical derivations, and their meanings.

Course Description

The Medical Science AP Physics B course will begin with observations of objects in motion, focusing on multiple representations of motion, the mechanics of moving objects and using the scientific method to solve real world problems. As the course progresses, the students will gain an understanding that the same basic principles and models govern the motion of all objects. They will gain this understanding through the use of various laboratory activities involving scenarios and examples that demonstrate these principles. Students will also gain a practical understanding of the gravitational force between objects of mass; it is a universal force of attraction and that the force is proportional to the product of the masses and the proportionality of the distance follows an inverse square law. Along with these topics, students will also gain an understanding that energy takes many forms and is a property of many substances; it is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature chemicals. Students will explore these forms and come to understand that energy is transferred in many ways, is conserved in a closed system and can be grouped into types of energy that are associated with an object's motion (kinetic energy), and types of energy associated with the object's position and with energy fields (potential energy). Students will then explore the nature of waves and how their movement impacts us every day; including sound and seismic waves, waves on water, and light waves. Students will also come to have an understanding that waves have energy and can transfer energy when they interact with matter. During the study of charges, magnetic properties, and electromagnetism, students will gain an understanding of electromagnetic forces and how they affect matter and energy. Optics will also be studied and students will come to understand how we are able to see objects and will gain an understanding of the nature of light, its properties, and how it interacts with matter by transmission, absorption and scattering.

Students' understanding will be evaluated through methods such as pre- and post-test analysis, lab activities, projects, mid-term and final course assessment.

Freehold Regional High School District
Curriculum Map

M/S AP Physics B

Relevant Standards[1]	Enduring Understandings	Essential Questions	Assessments: Diagnostic (before)	Assessments: Formative (during)	Assessments: Summative (after)
5.1: A1-3, B1-4, C1-3, D1-3	Scientific method and technology can help in collecting evidence, forming explanations, connecting these explanations to scientific knowledge and theory, and in communicating and justifying these explanations. Understanding the development of scientific ideas is essential for building scientific knowledge.	What are the key elements to the scientific method? How is the scientific method used to answer questions and to solve problems? What is Physics and how does it relate to other sciences and the real world?	Pre-test Lab safety Pre-lab Brainstorming topics Pre-lab assessments Research Based Surveys (FCI, FMCI, ECCE, FMCE, CSEM, CSE, CSM, MBT, etc.) Anticipatory Sets (opening questions and activities)	Quizzes Daily checks for understandi ng Using whiteboards for instant feedback Journaling and reflective writing Lesson Closure questions Daily homework assessment Current events in Physics Portfolio of works in progress Progress Reports	Marking period project Questions on specific topics Post Unit Test Lab Reports Research Based Surveys (FCI, FMCI, ECCE, FMCE, CSEM, CSE, CSM, MBT, etc.)
	Mathematics is a language used to model objects, events, and relationships in the natural and designed world.	How can math be used to build models to help represent real world phenomena?			
	A system is when an observer examines an object (or multiple objects) and how the external environment interacts with the object(s).	What is a system and how it is identified?			
8.1A1-3,C1, D2, E1, F1	Technology is an application of scientific knowledge used to meet human needs and solve human problems.	Why is the safe and proper use of technology important? How can technology be used to conduct scientific investigations? How can technology be used to communicate scientific ideas to others in the scientific community? How can technology be used to enhance the scientific community's understanding of physical phenomena? How do advancements in physics affect technology and vice versa?			
5.2 A. Properties of Matter: All objects and substances in the natural world are composed of matter. Matter has two fundamental properties: matter takes up space, and matter has inertia.	Intrinsic properties of matter are: it has mass, takes up space, made of smaller moving parts (atoms and other subatomic particles), and has charges	What is mass? How many charges are there and what part of the atom is charged? What are magnets and how can you determine if something has magnetic properties?			

Relevant Standards[1]	Enduring Understandings	Essential Questions	Assessments		
			Diagnostic (before)	Formative (during)	Summative (after)
5.2: C. Forms of Energy: Knowing the characteristics of familiar forms of energy, including potential and kinetic energy, is useful in coming to the understanding that, for the most part, the natural world can be explained and is predictable.	Energy is a system's ability to do or change something. Energy takes many forms; the two major categories being: energies that are associated with the motion of an object (kinetic energies) and those that are associated with the position of an object within a field (potential energies)	What is energy and what are its different forms? What is the difference between an energy transform and an energy transfer? What is the difference between kinetic energy, potential energy in a uniform field, and potential energy in a non-uniform field?	Pre-test Lab safety Pre-lab Brainstorming topics Pre-lab assessments Research Based Surveys (FCI, FMCI, ECCE, FMCE, CSEM, CSE, CSM, MBT, etc.) Anticipatory Sets (opening questions and activities)	Quizzes Daily checks for understanding Using whiteboards for instant feedback Journaling and reflective writing Lesson Closure questions Daily homework assessment Current events in Physics Portfolio of works in progress Progress Reports	Marking period project Questions on specific topics Post Unit Test Lab Reports Research Based Surveys (FCI, FMCI, ECCE, FMCE, CSEM, CSE, CSM, MBT, etc.)
	Gravitational Potential Energy is proportional to the product of two masses within a system and inversely proportional to the distance between those objects. Electrical Potential Energy is proportional to the product of the two charges within a system and inversely proportional to the distance between those objects.	What does the gravitational potential energy depend on? What does electrical potential energy depend on? What is the difference between the types of potential energies?			
	There is a relationship between a change in electrical potential (voltage), resistance, current and power and a difference in electric potential is required for this relationship to exist in a closed circuit.	What is potential difference and how is created? How can a potential field be represented in words, physically, graphically and mathematically? How are current, a change in electric potential (voltage), and resistance related?			
5.2.D. Energy Transfer and Conservation: The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another	Work is a transfer of in and out of a system and power is the rate at which the change in energy occurs. A change in energies in a system of objects with mass is proportional to the magnitude of the forces exerted and mass. A change in energies in a system of objects with charge is proportional to the magnitude of the forces exerted and charge.	What is the difference between "work done on" a system and "work done by" a system? What is the relationship between work and the subsequent change in energy for a system and its surrounding environment?			
	Energy is conserved in a closed system.	What is the law of conservation of energy and how can it be represented physically, graphically and mathematically?			
	The components of electrical circuits provide a means of transferring electrical energy. **Various configurations of electrical circuits (parallel and series) will affect the current and potential differences for each individual electrical component (resistor and capacitors) in the circuit.**	What is Kirchoff's rule and how does it apply to circuits? What are the basic electrical circuit components (resistors, batteries, capacitors, inductors) and what are their applications? How are circuits in series different from circuits in parallel?			

Relevant Standards[1]	Enduring Understandings	Essential Questions	Assessments		
			Diagnostic (before)	Formative (during)	Summative (after)
5.2.D. Energy Transfer and Conservation: The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another	Mechanical waves (sound, seismic, water) require a medium in order propagate through space and time as a transverse or longitudinal wave.	How do waves transfer energy without transferring matter? How can waves be categorized? What do these types of waves depend on? What are the characteristics (reflection, refraction, interference and diffraction) of all waves? What is sound? What is the relationship between perceived qualities (pitch, volume, timbre) and physical quantities (frequencies, intensity/logarithmic scale, harmonics)? How is resonance applicable to sound? What is the Doppler Effect?	Pre-test Lab safety Pre-lab Brainstorming topics Pre-lab assessments Research Based Surveys (FCI, FMCI, ECCE, FMCE, CSEM, CSE, CSM, MBT, etc.) Anticipatory Sets (opening questions and activities)	Quizzes Daily checks for understandi ng Using whiteboards for instant feedback Journaling and reflective writing Lesson Closure questions Daily homework assessment Current events in Physics Portfolio of works in progress Progress Reports	Marking period project Questions on specific topics Post Unit Test Lab Reports Research Based Surveys (FCI, FMCI, ECCE, FMCE, CSEM, CSE, CSM, MBT, etc.)
	A change in electric field will result in a magnetic field and a change in magnetic field will result in an electric field. Electromagnetic waves do not require a medium in order to propagate yet transfer energy when interacting with matter. The electromagnetic radiation is classified by energy, subsequently the electromagnetic spectrum encompasses more than the visible portion. **Electromagnetic radiation, including the visible portion, can be described with the particle and/or wave model depending on the reference frame.**	What are the differences between mechanical and electromagnetic waves? What is the relationship between an electric current and a magnetic field? What is necessary in order to induce a magnetic field? An electric field? How are electromagnetic oscillations categorized? What were the models of electromagnetic radiation leading up to modern day and what is the current model?			
	Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). To see an object, light from that object—emitted or scattered from it—must enter the eye. Different types of optical devises(mirrors, lenses, diffraction grating, polarization) affect the image produced, these optical devises have various functions.	What are the characteristics (reflection, refraction, interference and diffraction) of light? What are different types of optical devices (cameras, simple magnifiers, eyeglasses telescopes, microscopes) and how do they produce an image? How can the location, size, orientation and type of image formed be predicted and represented physically and mathematically?			

Relevant Standards[1]	Enduring Understandings	Essential Questions	Assessments		
			Diagnostic (before)	**Formative (during)**	**Summative (after)**
5.2: E. Forces and Motion**: It takes energy to change the motion of objects. The energy change is understood in terms of forces.**	The same basic principles & models govern the motion of all objects when considering multiple dimensions.	How can a system's motion and change in motion be described? How can a system's motion be represented with words, physically, graphically and mathematically?	Pre-test Lab safety Pre-lab Brainstorming topics Pre-lab assessments Research Based Surveys (FCI, FMCI, ECCE, FMCE, CSEM, CSE, CSM, MBT, etc.) Anticipatory Sets (opening questions and activities)	Quizzes Daily checks for understandi ng Using whiteboards for instant feedback Journaling and reflective writing Lesson Closure questions Daily homework assessment Current events in Physics Portfolio of works in progress Progress Reports	Marking period project Questions on specific topics Post Unit Test Lab Reports Research Based Surveys (FCI, FMCI, ECCE, FMCE, CSEM, CSE, CSM, MBT, etc.)
	In order to change an object's motion, an unbalanced and external force(s) must be exerted on the object. When an object exerts a force on another object, the second object will exert a force that is equal in magnitude and opposite in direction on the first object.	What are the different types of forces? How are they different? How are they the same? How can the forces exerted on a system be represented physically, graphically, mathematically and with words? What are Newton's Laws of Motion and how do they affect a system's motion? How can you differentiate and calculate displacement, velocity, and acceleration in one and two dimensions? What is projectile motion? What is necessary for an object to travel in a circular path?			
	Gravitational force is a universal force of attraction between masses and that the force is proportional to the masses and inversely proportional to the distance squared.	How is gravitation force defined and conceptualized? What is Newton's Universal Law of Gravitation? How are mass and weight different?			
	In order to change an object's motion, an unbalanced and external force(s) must be exerted on the object over a period of time, causing an object to undergo a change in momentum. Momentum is conserved in a closed system.	What is the momentum of an object it be quantified? What is the meant by conservation of momentum? What is the relationship that exists between impulse and a change in momentum?			
	Simple machines can help by decreasing the force a human needs to exert in order to perform a task	What are the different types of simple machines and how are they used? What kind of advantages do simple machines have? What is the difference between efficiency and mechanical advantage?			

Relevant Standards[1]	Enduring Understandings	Essential Questions	Assessments		
			Diagnostic (before)	Formative (during)	Summative (after)
5.2: E. Forces and Motion**: It takes energy to change the motion of objects. The energy change is understood in terms of forces.**	Rotational Motion is when a system pivots about an internal axis and its rotation depends on the system's moment of inertia and the torque exerted on it. An object in equilibrium has a net torque of zero and has no angular acceleration	How is rotational motion different from circular motion? What is an object's center of mass and how can it be located? What factors determine if a system is at equilibrium?	Pre-test Lab safety Pre-lab Brainstorming topics Pre-lab assessments Research Based Surveys (FCI, FMCI, ECCE, FMCE, CSEM, CSE, CSM, MBT, etc.) Anticipatory Sets (opening questions and activities)	Quizzes Daily checks for understandi ng Using whiteboards for instant feedback Journaling and reflective writing Lesson Closure questions Daily homework assessment Current events in Physics Portfolio of works in progress Progress Reports	Marking period project Questions on specific topics Post Unit Test Lab Reports Research Based Surveys (FCI, FMCI, ECCE, FMCE, CSEM, CSE, CSM, MBT, etc.)
	An object undergoing simple harmonic motion when a restoring force is exerted on the object to bring it back to its equilibrium, such as a oscillating spring or a pendulum. Simple harmonic motion is a continuous and repetitive transform of energies within a system that when graphed has a sinusoidal function. Simple harmonic motion of an object is related mathematically to it position, velocity and acceleration as a function of time.	What constitutes something that is in simple harmonic motion? What physical systems display simple harmonic motion? What is the mathematical and graphical relationship between position, velocity and acceleration, as a function of the time for a physical system in simple harmonic motion? What is resonance and how is it applications to physical systems?			
	Charged bodies can attract or repel each other with a force that depends upon the size, the nature of the charges and the distance between them.	What are relationship between charge, force between charges and distance? How can electric interactions be represented in words, physically, graphically and mathematically?			
	The (electrical properties of) space surround a charged object is affected by the magnitude and type of charged particles. Electrical field lines represent the affect of these charged particles and can be used to represent how a force exerted on a test charge would be directed.	What is an electric field and how can they be represented physically, graphically and mathematically? What are electric field applications?			

Freehold Regional High School District
Course Proficiencies and Pacing

M/Science AP Physics B

Unit Title	Unit Understandings and Goals	Recommended Duration
ALL UNITS: Scientific processes, mathematics and safety	Scientific method and technology can help in collecting evidence, forming explanations, connecting these explanations to scientific knowledge and theory, and in communicating and justifying these explanations. **Continuous Goal:** Students will develop problem-solving, decision-making and inquiry skills and will understand how people, discoveries and events have contributed to the advancement of science and technology.	Ongoing in conjunction with all other units.
Unit #1: Motion	The same basic principles & models govern the motion of all objects. **Goal:** Students will gain an understanding of how a system's motion can be described.	2 weeks
Unit #2: Newtonian Dynamics	External, unbalanced forces are required to get a system to change its motion. Objects that exert forces on a second object will have equal on opposite forces exerted it by the second object. **Goal:** Students will gain an understanding of Newton's laws and how they affect a system's motion.	2 weeks
Unit #3: Universal Law of Gravitation (Universal Law of Gravitation topic can be done either before OR after Two Dimensional Motion. Kepler's Laws should be done in whichever of the two topics is done secondly.)	Gravitational Force is a universal force of attraction between masses and that the force is proportional to the masses and inversely proportional to the distance squared. **Goal:** Students will understand that all objects with mass exert forces on other object with mass.	1 week
Unit #4: Two Dimensional Motion	The same basic principles and models govern the motion of all bodies when considering multiple dimensions. **Goal:** Students will gain an understanding of Newton's laws and how they affect a system's motion in multiple dimensions.	2 weeks
Unit #5: Rotational Motion	A system's equilibrium depends on the center of mass and torque exerted on the system. **Goal:** Students will gain an understanding of the mechanics of rotational motion and be able to calculate torque, moment of inertia and angular acceleration of this motion.	5 weeks
Unit #6: Conservation Laws-Momentum	Momentum is a physical quantity that only moving objects have and the total momentum of a system is conserved. **Goal:** Students will understand that momentum is conserved in a closed system.	5 weeks
Unit #7: Conservation Laws-Work & Energy	Energy takes many forms; these forms can be grouped into types of energy that are associated with the motion of mass (kinetic energy), and types of energy associated with the position of mass and with energy fields (potential energy). Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways. Energy is conserved in a closed system. Simple machines can help by decreasing the force a human needs to exert in order to perform a task. **Goal:** Students will understand that energy and momentum are conserved within a system.	3 weeks

Unit Title	Unit Understandings and Goals	Recommended Duration
Unit #8: Thermodynamics	The motion of particles that make up a system affect that system's temperature, internal energy and its ability to heat or be heated. **Goal:** Students will gain an understanding of what matter is and how forces and energy affect the properties and internal motion of an system.	2 weeks
Unit #9: Simple Harmonic Motion & Waves	Waves, including mechanical and electromagnetic waves, have energy and can transfer energy when they interact with matter. Simple harmonic motion is a transform of energy within a system such as an oscillating spring or a pendulum. **Goal:** Students will understand the characteristics and properties of wave and wave motion.	2 weeks
Unit #10: Sound	Sound is a transfer of energy through a medium in the form of a compression wave. **Goal:** Students will understand the characteristics and properties of sound.	2 weeks
Unit #11: Electrostatics	Charged bodies can attract or repel each other with a force that depends upon the size and nature of the charges and the distance between them and that electric forces play an important role in explaining the structure and properties of matter. Electromagnetic and gravitational forces can be used to produce energy by causing physical changes and relate the amount of energy produced to the nature and relative strength of the force. **Goal:** Students will gain an understanding of electromagnetic forces and how they affect matter and energy.	2 weeks
Unit #12: Electricity	There is a relationship and what the relationship is between voltage, resistance, current and power. Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced. **Goal:** Students will gain an understanding of electromagnetic forces and how they affect matter and energy.	2 weeks
Unit #13: Electromagnetism	A change in electric field will result in a magnetic field and a change in magnetic field will result in an electric field. The electromagnetic spectrum encompasses more than the visible part of the spectrum. **Goal:** Students will gain an understanding of electromagnetic forces and how they affect matter and energy.	2 weeks
Unit #14: Light & Optics	Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). To see an object, light from that object—emitted or scattered from it—must enter the eye. **Goal:** Students will gain an understanding of light and how images are formed using different optical devices.	3 weeks
Unit #15: General & Special Relativity	The laws of physics apply to all reference frames. Whether an observer is moving or not, the speed of light is constant. **Goal:** Students will gain an understanding of how a reference frame is used to explain and describe motion.	1.5 weeks
Unit #16: Atomic and Nuclear Physics	Atoms are made of smaller particles (protons, electrons, and neutron) that remain bound to an atom due to nuclear and electric forces. Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and thus can absorb and emit light only at wavelengths corresponding to these amounts. **Goal:** Students will gain an understanding that there are nuclear forces at the subatomic level and the interactions of these forces.	1.5 weeks

N.B. To complete all topics before AP College Board Physics B Exam, each topic must be covered in the minimum time allowance (approximately 30 weeks). Based on past AP Exams, Topics: General and Special Relativity and Atomic and Nuclear Physics have the least percentage of questions asked and are therefore placed at the end to allow for more time in other topics if required.

Since the AP College Board Physics B Exam focuses on Electrostatics, it is suggested that the topics Simple Harmonic Motion and Waves and Sound (Units 9 and 10) be pushed back and done after Units 11, 12 and 13 if not covered before the Midterm Exam. Electrostatics must be started at the beginning of February for pacing and weather reasons (best to do Electricity in cold, dry weather). This is different than the order of topics in the textbook.

Freehold Regional High School District
M/S AP Physics B

ALL UNITS: Scientific Processes, Mathematics, Technology, and Safety

Enduring Understandings: Scientific method and technology can help in collecting evidence, forming explanations, connecting these explanations to scientific knowledge and theory, and in communicating and justifying these explanations.
Understanding the development of scientific ideas is essential for building scientific knowledge.
Mathematics is a language used to model objects, events, and relationships in the natural and designed world.
Technology is an application of scientific knowledge used to meet human needs and solve human problems.
A system is when an observer examines an object (or multiple objects) and how the external environment interacts with the object(s).

Essential Questions: What is Physics and how does it relate to other sciences and the real world?
What are the key elements to the scientific method?
How is the scientific method used to answer questions and to solve problems?
How can math be used to help represent real world phenomena?
Why is the safe and proper use of technology important?
How can technology be used to conduct scientific investigations?
How can technology be used to communicate scientific ideas to others in the scientific community?
How can technology be used to enhance the scientific community's understanding of physical phenomena?
How do advancements in physics affect technology and vice versa?
What is a system and how it is identified?

Continuous Goal: Students will develop problem-solving, decision-making and inquiry skills and will understand how people, discoveries and events have contributed to the advancement of science and technology.

Duration of Unit: Throughout academic year – dispersed through the first two marking periods and reinforced in the second half of the year.

NJCCCS: 5.1 (A1-3, B1-4, C1-3, D1-3), 8.1(A1-3, C1, D2, E1, F1)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
What practices and habits will insure safety in the classroom and laboratory? ________________ How is the scientific method used to answer questions and to solve problems? What is necessary in order develop and test a scientific hypothesis? What constitutes valid evidence and when do you know you have enough and the right kind of evidence? What is precision, accuracy and uncertainty analysis? How can results be best justified and explained to others?	Demonstrate self-management skills; such as work ethic, dependability, promptness, the ability to set short and long term goals, work cooperatively, use time efficiently and develop self-evaluation skills. ________________ Locate, develop, summarize, organize, synthesize and evaluate information. Use scientific inquiry to ask scientifically-oriented questions, collect evidence, form explanations, connect explanations to scientific knowledge and theory, and communicate and justify explanations. Develop critical thinking, decision–	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales, computer hardware and software. Teacher and student editions of text approved by the district. Scientific / graphing calculators Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu	Mini-lab on lab safety and measurement. Write up lab in approved laboratory format. Activity on Scientific method such as a "thought" experiment where students justify their logical solution. Guided discussion based upon results form survey and questionnaire.	Lab Reports Safety quiz Pre-test to determine student knowledge base and skills. Homework and practice problems pertaining to basic metric conversions, scientific notation, significant figures, and math skills Post-test to determine student progress.

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
Why is communication among the scientific community essential for presenting findings?	making, problem-solving skills and data analysis skills.	phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html	Ongoing infusion of important scientists and their developments throughout the course.	Technology survey to determine student understanding of the concept. Questionnaire about careers in technology and science and their impact on our daily lives.
Why is it necessary for all scientists to use a common system of measurement? What are the basic units of measurement and the various prefixes used in the scientific community?	Use metric system (kg-m-s), recognize metric prefix meanings and convert to base units.			
How do science and technology influence each other? How does scientific knowledge advance and build upon previous discoveries using the scientific method of problem solving?	Develop an understanding of the role that Physics serves as a foundation for many career opportunities in science and technology. Properly and safely use technology and scientific equipment to collect and analyze data to help form scientific testable scientific hypotheses.			
What is the importance of history in understanding scientific theories and the advancement of science? What is Physics? What is the role of physics in the world around us?	Understand that the development of ideas is essential for building scientific knowledge.			

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Essential Vocabulary:
Scientific method, theory, observation, inference, prediction, hypothesis, safety, experiment, dependant and independent variable, control, SI units, meters, liters, kilograms, technology, communication, findings, results, conclusion, data, analysis

Possible Projects: Laboratory Safety Posters, Instructional Manual

Freehold Regional High School District
M/S AP Physics B

Unit #1: One Dimensional Kinematics

Enduring Understanding: The same basic principles & models govern the motion of all objects.
Essential Questions: How can a system's motion and change in motion be described?
How can a system's motion be represented with words, physically, graphically and mathematically?
Unit Goal: Students will gain an understanding of how a system's motion can be described.
Duration of Unit: 2-3 weeks
NJCCCS: 5.2 E (1, 2)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales of various sorts, and glassware. PASCO Equipment ESPECIALLY→ constant	Observations of objects moving in different ways (teacher walking across classroom, teacher waving arms around, teacher jumping up and down.)	Pre Test on Motion Lab Activities- Speed of a Bowling Ball → Data collection and analysis. White Board Presentation of Data
What role does a reference frame play in determining the motion of an object?	Determine if an object is moving and explain answer.	velocity vehicles (like bowling ball), friction cars, objects to drop, tickertape timers with tape, motion sensors, rollerblades or	Drawing pictures to represent scenario (pictures, motion diagrams, vectors), describe using words and numbers.	Friction Cars (Changing horizontal speed)→ Data Collection and analysis Compare and contrast to
How can motion be described and depicted? What different types of motion are there?	Collect data from moving objects and analysis information in the form of graphs and tables. Find patterns in data and use these patterns to develop models and explanations.	skateboard, beanbags (or sugar packets) Teacher and student editions of text approved by the district. Scientific / graphing calculators	Objects that move with constant horizontal velocity- Bowling Ball (or constant motion cars) Objects that Change Velocity	bowling ball activity Freefalling Objects→ Data collection and analysis, new model developing, compare and contrast to friction cars
What is meant by magnitude and direction when describing motion? What is meant by vector and scalar quantity? How are speed and velocity different? What is the difference between vector and scalar quantities?	Recognize the importance of vectors and scalars in determining an objects motion. Draw and add vectors to find the resultant or missing component Differentiate between resultant and vector components.	Possibly a math book for algebraic and calculus reference and example problems.	(horizontally)-Friction cars (accelerating cars)- These can be attached to tickertape timers and tape to make motion diagram or you can use video and a frame by frame or sugar packets to drop along side every second.	Acceleration of a Freefalling Object→ Data collection using PASCO sensors to collect and calculate the acceleration of the falling "picket fence". Quizzes on making and interpreting graphs, describing
What are displacement, velocity, and acceleration? What is the difference between instantaneous and average velocities? How can an object's motion be represented?	Define key terms regarding the motion of an object. Draw motion diagrams to represent a given scenario. Interpret displacement, velocity, and	Access to Computers and Internet Internet resources:	Objects that change velocity (vertically) Freefalling objects- drop objects simultaneously. Should be different masses and different shapes, also have similar masses and similar	motion (in words and pictorially), determining, acceleration, speed (and velocity), position and time intervals Homework (collected,

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	acceleration vs. time graphs. Apply the mathematical and graphical relationships between position, time, velocity and acceleration	islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1	shapes.- Do frame by frame or attach to tickertape timer. If access to motion sensors, can also use this to plot data.	checked, gone over in class) Check students' use of vocabulary and explanations throughout lessons
How do displacement, time interval, velocity and acceleration relate to each other? How do you analyze the relationship of velocity to acceleration? How do you interpret instantaneous/average velocity and acceleration graphically? How do you depict constant and changing velocity graphically? How are slope and area applied to graphical representations of motion?	Apply the mathematical concepts of slope and area between the curve and time axis to analyze displacement, velocity and acceleration for a position vs. time, velocity vs. time and acceleration vs. time graphs.	www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html Videos (internet, DVD and VHS accessible) to watch frame by frame or regular speed, "Frames of Reference" PUM (Physics Union Math) and ALG (Active Learning Guide) Activities for Motion (Kinematics Module)	Problem solving steps and techniques: Read the problem multiple times, make a list of given information, and what needs to be found. Draw a picture with labels of the situation Represent the problem with mathematical expression, a graph and a motion diagram. Adjust expression to solve for the unknown variable. Enter in the given information (including unit labels). Solve for unknown.	Problem Solving and Board Work Closure- "What have I learned today and why do I believe it?" "ABC" cards (multiple choice questions where students show their answer choice to teacher) "How does this relate to...?" "What still remains unclear?" Weekly (or daily) Journal Writing (reflection of lessons and learning)
How are horizontal motion and vertical motion different? How are they similar? How does the pull of Earth and air resistance affect the acceleration of falling objects?	Compare and contrast horizontal motion and motion of a freely falling object.	Real world handouts (i.e. Traffic school papers detectives use for accidents (ask at your police station)).	Teacher Modeling	Quest – Motion (1-D)
How do students represent and analyze a system of two moving objects, for constant velocity and acceleration?	Apply the mathematical and graphical relationships between position, time, velocity and acceleration to a two bodied system. Derive mathematical expressions for velocity, acceleration and displacement		Individual work, group work Think, Pair, Share opportunities, whiteboarding, student presentation class discussions Blogs, wikis, scientific journal readings and current events	Two bodied motion assessment: using various representations predict, test and evaluate where two objects (with initial given parameters) will meet. AP Exam Sample Problems

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.
- Provide technology (in forms of hardware, software and interactive discussion groups/forums) to facilitate data collection, analyzing, and reporting conclusions.

Essential Vocabulary:
Reference Frames, inertia, velocity, speed, vector, scalar, distance, displacement, position, acceleration, resultant, stationary, at rest, system, motion, constant, change, time interval, clock reading, path length

Possible Projects: Building Constant Motion Vehicles

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Unit #2: Newtonian Dynamics

Enduring Understanding: In order to change an object's motion, an unbalanced and external force(s) must be exerted on the object.
When an object exerts a force on another object, the second object will exert a force that is equal in magnitude and opposite in direction on the first object.

Essential Questions: What are Newton's Laws of Motion and how do they affect a system's motion?
What are the different types of forces? How are they different? How are they the same?
How can the forces exerted on a system be represented physically, graphically, mathematically and with words?

Unit Goal: Students will gain an understanding of Newton's laws and how they affect a system's motion.

Duration of Unit: 2-3 weeks

NJCCCS: 5.2 E (1-4)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales of various sorts, and glassware. ESPECIALLY→ spring scales, bathroom scales, carts with masses, pulleys, scooters or skateboards, ropes, access to elevator, incline planes, various surfaces, etc. Teacher and student editions of text approved by the district. Scientific / graphing calculators Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html	Drop different weight objects into students hands (kick ball and medicine ball or bowling ball) Drawing pictures to represent pictures, force diagrams, vectors, describe using words and numbers. Observations of objects moving in different ways depending on amount of net force and mass of objects Formulate the mathematical expression for Newton's Second Law. Use force diagrams and Newton's second law to represent forces and their components exerted on an object. Use two force sensors in collisions and other interactions to have students develop the concepts of Newton's Third Law.	Pre-Test on Forces Force Concepts Inventory (diagnostic) FCME Lab Activities- Acceleration of a Dynamics Cart→ Data collection and analysis Normal Force → Students analyze the forces exerted on objects of different mass that compress or stretch materials, in particular, the magnitude of the force perpendicular to the surface on the object. Frictional interactions → by dragging objects across various surfaces students can take force reading required to get the object moving and to keep the object moving at constant velocity. The coefficient of static friction on a horizontal surface & incline → Students collect data with spring scale or force sensor to calculate the
How can you physically/pictorially represent the forces exerted on a system?	Identify a system and external objects that interact with it. Differentiate between types of interactions and how to label and draw them in physical representations. Use vectors to represent the vector quantity of Force.			
How are balanced and unbalanced forces represented? How do you determine the net force on an object?	Draw force and motion diagrams to represent a given scenario. Identify situations of equilibrium and when they are not.			
How does Newton's first law relate to constant motion (v=0), zero net force? How can the relationship between mass, net force and acceleration be represented mathematically? What is the cause and effect relationship between net force, mass and acceleration as described in Newton's Second Law?	Determine the mathematical relationship between the mass of an object, the forces exerted on it and the acceleration of the object. Determine net force on an object in motion and at rest and predict the magnitude and direction of acceleration.			

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
What is Newton's third law? How can any side of a tug of war win if Newton's 3rd law is true?	Identify force pairs and understand that these pairs are two separate objects acting upon one another with potentially different net force magnitude and direction.	Videos (internet, DVD and VHS accessible) to watch frame by frame or regular speed PUM (Physics Union Math) and ALG (Active Learning Guide) Activities for Forces (Dynamics Module)	Scale readings of hanging objects (attached to one scale and attached to two scales) Observations of objects moving across different surfaces and the forces required to move those objects. Formulate an expression for the force of the Earth exerted on an object by using a spring scale to measure objects of various mass Scale reading in an accelerating elevator (can also be done with a mass, spring scale and a teacher pulling up on the scale or allowing it to drop slightly… any acceleration will give a different reading on the scale) Think, Pair, Share opportunities Class discussions	coefficient of static friction between a sneaker (or object) and a horizontal board of wood. Students use the information to predict the angle at which the shoe would begin to slide down an incline. 3-D Force Diagrams (with Styrofoam and pipe cleaners) accompanied with a story/scenario Quizzes on- drawing force diagrams, finding net force, calculating acceleration, mass vs. weight, interpreting diagrams, identifying force pairs Jeopardy type questions (you give answer and students need to pose the question) Application to previous topics Quest- Forces AP Exam Sample Problems
What is the difference between a field force and a contact force?	Identify different types of forces and their effects on motion.			
What are the types of friction? Why does friction occur?	Identify the factors (coefficient of friction and the "normal" force) that affect the frictional interactions.			
How can Newton's Laws, force diagrams, and motion diagram be utilized to represent various applications, such as but not limited to inclines, elevators, etc.? How do students represent and analyze a system of two or more objects, for constant velocity and acceleration?	Solve for different variables of for objects in motion using Newton's Laws of Motion.			
What is the role of inertial and non-inertial reference frames in applications of Newton's Laws?	Recognize Newton's Laws do not apply to objects in an accelerated reference frame.			
What is the role of a "massless string"? What is the role of a "frictionless pulley"?	Recognize that "massless strings" and "frictionless pulleys" connect objects without external consequences.			

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.
- Provide technology (in forms of hardware, software and interactive discussion groups/forums) to facilitate data collection, analyzing, and reporting conclusions.

Essential Vocabulary:
Reference Frames, inertia, equilibrium, net force (unbalanced), resultant, interaction, force (net force) diagrams, acceleration, stationary, third law force pairs, friction, tension, compression, contact forces, field forces (gravitational, electric, magnetic, nuclear- strong & weak), weight, mass, system, constant

Possible Projects: Helium Balloon Race -slowest to reach the top (could also be used for buoyancy unit), Building Towers. Bridges, or Boomilevers/Cantilevers

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Unit #3: Universal Law of Gravitation*

Enduring Understanding: Gravitational force is a universal force of attraction between masses and that the force is proportional to the masses and inversely proportional to the distance squared.

Essential Questions: How is gravitation force defined and conceptualized?
What is Newton's Universal Law of Gravitation?
How are mass and weight different?

Unit Goal: Students will understand that all objects with mass exert forces on other objects with mass.

Duration of Unit: 1 week

NJCCCS: 5.2 (E)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	ALL: Reinforce and continuously use scientific method and critical thinking processes.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales or various sorts, and glassware.	Relating Newton's 3rd Law of Motion to ALL objects. Ask students if the Earth pulls on an apple, shouldn't the apple pull on the Earth? Focus on the magnitude of the Force between the Earth and apple. Compare to Earth and Moon.	Pre Test on Gravitational Forces
What is gravitational interaction and what object exerts the gravitational force in everyday life? What type of interaction occurs when considering gravitational forces? How can the gravitational interaction on a system near the Earth's surface be calculated? In what ways is gravitational force explained by Newton's third law? What is the Universal Law of Gravitation? What is the mathematical expression for the Universal Law of Gravitation and how can variables be solved for using the expression?	Identify the objects involved in gravitational interaction on Earth Recognize that gravitational force is universal and attractive, not repulsive. Recognize the gravitational force as a field force Relate gravity (gravitational force) to Newton's 3rd Law. Calculate gravitational force using the Universal Law of Gravitation (ULOG) and the universal gravitational constant "G".	Especially→ stretchy material , spherical objects of mass (for Einstein's analogy Teacher and student editions of text approved by the district. Scientific / graphing calculators Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html	Graph the acceleration due to the pull of the Earth at different altitudes and different latitudes. Calculate the weight of an object at these different altitudes and latitudes. Calculate for the mass of an object when it weighs a certain amount on the surface of different planets Graph and find relationships between gravitational force and distance between objects.	Lab Activities- What's your Weight?→ Data collection, calculation, graphing and data analysis. Students make conclusion of dependence of location and mass to weight. Answer questions about mass, weight, and location. Discovering Universal Law of Gravitation→ Use prefabricated data of gravitational force and distance. Students graph and analyze Use prefabricated data of gravitational force and product of masses. Students graph and analyze White Board Presentation of Data to class
What is a gravitational field and what are the factors that affect the field strength? What is the operational definition for a gravitational field? Why is $9.8 m/s^2$ not "gravity"?	Differentiate between gravitational force, the resulting acceleration of an object, and the mechanism that causes the attraction, the field. Use Einstein's analogy of the alteration of space-time to explain how two	http://www.phy.mtu.edu/links/Interactive_Physics.html Videos (internet, DVD and VHS accessible). *The Elegant Universe Hour 1 part 2 & 3*	Graph and find relationships between gravitational force and product of objects' masses Observations of Moon's path	Quizzes on weight and mass, calculating acceleration due to gravity, ranking weights at different locations, using

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
What does 9.8 N/kg mean about the Earth's interaction with objects of mass? What is "weight"? How does weight depend upon location? What does a bathroom scale measure? What is the difference between mass and weight? Why do we consider acceleration due to the gravitational pull of the Earth to be constant when in actuality it is not? How is circular motion related to gravitational forces? Why are gravitational forces not considered the primary force at the atomic/sub-atomic level? *What are Kepler's three planetary laws and how will they be used (including assumptions) to predict planetary motion?	objects can interact without touching each other. Calculate the gravitational field strength at different points/locations around the Earth and on other planets. Recognize that the word "weight" is the force exerted by the Earth on an object. Recognize that a bathroom scale measures the force exerted by the scale on the object placed upon it. Differentiate between and calculate mass, weight and acceleration due to gravity. Identify when acceleration due to gravity can be considered constant and when it is not. *Recognize that gravitational forces can be the cause for an object's circular motion Compare objects at microscopic and macroscopic levels that are affected by gravitational forces and may result in circular motion. Explain why gravity is a macro-concept and not a micro-concept. *Approximate planetary motion to circular motion around the Sun.	*What's the Matter with Gravity* Blanket, baseball and marble for Einstein's analogy. PUM (Physics Union Math) and ALG (Active Learning Guide) Activities in Gravitational Forces	around Earth, Earth's path around Sun Develop models on shape of path and what causes this path Predict and test using planet's path around Sun (Relating Newton's 3rd Law of Motion to Circular Motion to get ideas of Planetary Motion) Historical Significance of the Motion of Planets and the Universal Law of Gravitation (Copernicus, Tycho Brahe, Johannes Kepler, Isaac Newton, Henry Cavendish) Graph and find relationships between gravitational field and product of objects' masses Compare and contrast motion of electrons around atomic nucleus to planets. (This would require students to have prior knowledge of atomic structure and the property of matter: charges. Use at teacher's discretion)	universal law of gravitation to solve for unknown, interpreting graphs, describing motion (in words and pictorially), planetary motion Homework (collected, checked, gone over in class) Check students' use of vocabulary and explanations throughout lessons Problem Solving and Board Work Closure- "What have I learned today and why do I believe it?" "ABC" cards (multiple choice questions where students show their answer choice to teacher) "How does this relate to...?" "What still remains unclear?" Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Gravitational Force AP Exam Sample Problems

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.
- Advanced students can explain current theories of gravity at the atomic and sub-atomic levels.

Essential Vocabulary:
Universal Law of Gravitation, gravitational force, gravity, attraction, inverse square law, field forces, weight, mass, gravitational constant, planetary motion, gravitational field

Possible Projects: Planetary Motion Model or Poster, Review Paper on Elegant Universe Theories

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Unit #4: Two Dimensional Kinematics*

Enduring Understanding: The same basic principles & models govern the motion of all objects, when considering multiple dimensions.
Essential Questions: How can a system's motion and change in motion be described?
How can a system's motion be represented with words, physically, graphically and mathematically?
Unit Goal: Students will gain an understanding of Newton's laws and how they affect a system's motion in two dimensions.
Duration of Unit: 1-2 weeks
NJCCCS: 5.2 E (1-4)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales or various sorts, and glassware. ESPECIALLY→ projectile launchers, tennis balls, simultaneous marble drop apparatus, strings with rubber stopper attached, bucket with long handle to swing in vertical and horizontal circles Teacher and student editions of text approved by the district. Scientific / graphing calculators Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html Videos (internet, DVD and VHS accessible) to watch frame by frame or regular speed	Observations of objects moving in different ways- thrown up into the air while thrower is stationary, thrown up into the air while thrower is walking at a constant velocity, dropped from the edge of a table, rolled off a table, tossed to a catcher. Have students try to get a ball to move in a circular path and report what was necessary to get it to move that way Swing a bucket of water in a circle Have students swing arm in a circle Use real life experiences of objects moving in circular motion- race cars on a track, the Moon around the Earth (Earth around Sun) and ask students to think about what kind of forces are cause the objects to move in a circle Drawing pictures to represent scenario (pictures, force diagrams, vectors), describe	Pre-Test on 2-D Motion Lab Activities- Projectile Motion→ Qualitative Analysis Students try to project ball into a bowl Circular Motion→ Quantitative analysis, examine videos or demonstrations for objects moving in circular motion. (i.e. a Ferris wheel, a ball in a hoop, etc) Qualitative analysis Student Conclusions Quizzes on- projectile motion and aspects, drawing force diagrams, finding net force (centripetal), calculating centripetal acceleration, interpreting diagrams Problem Solving and Board Work Checking use of vocabulary and student explanations during lessons Closures
What is projectile motion? In ideal conditions, what are the horizontal and vertical motions of a projectile?	Understand that projectile motion includes acceleration in the vertical direction and constant velocity in the horizontal.			
What is the shape of the trajectory? Why is the shape of the trajectory of an object in projectile motion parabolic?	Draw horizontal and vertical motion diagrams for an object in projectile motion. Draw the force and motion diagrams of an object in projectile motion and use it to explain the motion diagrams Apply vectors to projectile motion to demonstrate parabolic shape and determining resultant velocities.			
What variables affect the range, altitude and time of flight?	Identify the variables that affect range, time of flight and altitude. Draw and label the range, trajectory and altitude of an object in projectile motion. Apply previously derived Kinematics Equations to multidimensional motion. Calculate different variables pertaining to projectile motion.			

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
What is necessary for an object to maintain circular motion? What is the direction of the net force and acceleration on an object that is in circular motion?	Understand circular motion and draw and label diagrams to explain it. Give and explain examples of objects in circular motion and the forces that allow them to maintain that motion. Use components to determine the net force that keep an object in circular motion.		using words, describe using numbers Problem Solving steps and techniques Teacher Modeling Individual work Group work Think, Pair, Share opportunities Class discussions Explain the circular motion of various amusement park rides. Use the "movie physics" to determine if stunts are realistic Use launchers to determine range Create a project to examine the banking angle of a turn.	Jeopardy type questions (you give answer and students need to pose the question) Application to previous topics Journal Writing Quest- Motion (2-D) UNIT TEST- Motion (1 and 2 dimensions) and Forces AP Exam Sample Problems
What is the difference between the concepts of centripetal and centrifugal force?	Differentiate between centripetal and centrifugal motion. Realize that there is no object exerting a force directed away from the center of the circle.			
*How is circular motion related to gravitational forces?	*Recognize that gravitational forces can be the cause for an object's circular motion			
*What are Kepler's three planetary laws and how will they be used (including assumptions) to predict planetary motion?	*Approximate planetary motion to circular motion around the Sun.			

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Essential Vocabulary:
Orbit, projectile motion, trajectory, range, altitude, parabola, centripetal, centrifugal

Possible Projects: Building Mini Catapults, Trebuchets

*** Unit on the Universal Law of Gravitation can be done either before OR after 2 Dimensional Motion. If done before, Kepler's Laws should be done with Circular Motion. If Universal Law of Gravitation is done after, Kepler's Laws should remain within the topic of Universal Law of Gravitation.**

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Unit #5: Rotational Motion

Enduring Understandings: There is a difference between circular and rotary motion that depends on the axis in which the object moves about.
Rotary terms can be translated into linear terms and vice versa.

Essential Questions: What are the linear counterparts to rotary terms and how can they be converted?
What is the moment of inertia, what does it depend on, and how does it differ from inertia?
What is the relationship between angular acceleration, torque, and the momentum of inertia?

Unit Goals: All students will gain an understanding of the mechanics of rotational motion and be able to calculate force mass and acceleration of this motion.

Duration of Unit: 1.5 weeks

NJCCCS: 5.2 E (1-4)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales of various sorts, and glassware. ESPECIALLY→ Spheres, rings, disks, incline planes, balances, turn table, record Teacher and student editions of text approved by the district Scientific/ graphing calculator Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html Videos (internet, DVD and VHS accessible)	Race downhill for different shaped, mass and radius objects "Goo" tube anomalous data→ Using novelty timer that has very viscous goo in it, cover completely so you cannot see the goo. Allow to roll down incline, it will act very differently from other objects (cans of cream soups will also act similarly but not as dramatic) Revolution vs. Rotation Observations of a couple of pennies on a record on a turn table. Compare the speeds of the pennies, the period, the rotation and revolution of pennies and record Torque demo→ a T shaped handle with eyehooks placed at different distances from the intersection. Have students hold on the top of the T and	Lab Activities Application Experiment→ Balancing objects: Using meter sticks and pivot on stand, students hang masses on meter stick some distance away and find position where meter stick will be in equilibrium (when another mass at another position is put on it) Students calculate and test. Percent error can be found between calculated position and the actual position. Quizzes on moment of inertia, rotary terms, conversions, finding rotational unknowns, torque, center of mass Homework (collected, checked, gone over in class) Check students' use of vocabulary and explanations throughout lessons Problem Solving and Board
What factors affect the moment of inertia for a rotating object? How can the moment of inertia be found for a rotating object?	Determine what factors affect the moment of inertia for rotating objects Calculate the moment of inertia for different objects			
How can you change radians to degrees? Degrees to radians?	Relate radians to degrees. Convert between the two units of measurements.			
How are angular displacement, angular velocity, and angular acceleration related?	Calculate angular displacement using the arc length and the distance from the axis of rotation.			
What is the difference between an object that is revolving and an object that is rotating?	Differentiate between rotation and revolution.			
What is the difference between angular and linear terminology? How can you convert between linear and angular terms? How can linear kinematics be used	Compare and contrast angular terms to linear terms Solve problems using the kinematics			

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
to solve for rotating objects?	equations for rotational motion. Find the tangential speed of a point on a rigid rotating object using the angular speed and the radius. Calculate angular speed or angular acceleration.		hang masses from different eyehooks. Ask students which positions were the hardest to keep the T parallel to the ground	Work Closure- “What have I learned today and why do I believe it?” “ABC” cards
What is torque? What is a pivot point?	Define torque as a force exerted perpendicularly at some distance from a pivot point (the point at which there is no motion)		Pulling on roll of toilet paper: What’s the best way? Students use torque to come up with best way to get toilet paper off roll.	“How does this relate to...?” Represent and Reason Jeopardy Questions “What still remains unclear?” Write your own physics problem
How can torque and angular acceleration be calculated?	Calculate torque and resulting angular acceleration Differentiate between systems in equilibrium and those that are accelerating- an object in equilibrium will have no net torque and no angular acceleration but can still be rotating		Boys vs Girls center of mass competition: Have males and females perform different tasks where success (and failure) depends on location of center of mass.	Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Rotational Dynamics AP Exam Sample Problems
Where is the center of mass located for different objects? How can you find the center of mass for different objects? What is the difference between non-uniform and uniform objects? What is the difference between asymmetric and symmetric objects? Why are females more successful at performing certain tasks than males?	Find the center of mass for any combination of uniform, non-uniform, symmetric and asymmetric objects Relate student ability to perform certain tasks to location of center of mass Apply conservation laws to rotating objects (angular momentum and rotational kinetic energy)			

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Essential Vocabulary:
moment of inertia, radians, degrees, angular displacement, angular velocity, angular acceleration, torque, pivot, axis of rotation, rotation, revolution, static equilibrium, center of mass, balanced, symmetric, asymmetric, uniform, non-uniform, angular momentum, rotational kinetic energy

Possible Projects: Build a Mobile

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Unit #6: Conservation Laws- Momentum

Enduring Understandings: Momentum is a physical quantity that only moving objects have.
Momentum is conserved in a closed system.
Essential Questions: What is the momentum of an object?
What is the meant by conservation of momentum?
What is the difference between impulse and momentum?
Unit Goal: Students will understand that momentum is conserved within a system.
Duration of Unit: 2 weeks
NJCCCS: 5.2(D4, E1-4)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
  What is the momentum of an object, what factors does it depend on and how can it be calculated? How is Newton's 3rd and 2nd law related to interacting (i.e. collisions, explosions) objects? How can you express Newton's Second law as a function of time? What causes a change in momentum? What is the role of impulse and how does it differ from momentum?	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed. Define what momentum is and be able to calculate it for various situations. Recognize that momentum is a physical quantity that only moving objects have. Compare and contrast and object's momentum and inertia Recognize that changes in momentum stem from forces exerted between objects over periods of time. Express Newton's law as a function of time. Define impulse as the cause of a system's change in momentum and identify a net external force as the cause for a change in an object's motion.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales or various sorts, and glassware. ESPECIALLY→ collision carts (or low friction cars) with interchangeable bumpers (for elastic and inelastic), kick disks (for glancing and head on collisions), marble launchers, marbles and carbon paper for 2d collisions, "happy" bouncy ball, "sad" non-bouncy ball and a wooden block For paper labs, visit a local police station and ask the detective for a copy of the materials they use to calculate the car's motion (velocity, direction, etc) at accident scenes. (It is a good review of all mechanics) Teacher and student editions of text approved by the district Scientific/ graphing calculator	Observations of objects colliding: Head on: Elastic and Inelastic Glancing: Elastic and Inelastic Two objects moving: Towards each other, same direction but different speeds One object moving, one object stationary Relate change in velocity in given time period (acceleration) to the force of impact and mass of object (equate mathematic expressions for kinematics version of acceleration to dynamics version of acceleration to derive term for impulse) Use expression to define "impulse" Slow motion (frame by frame) of high-speed objects (like tennis ball, apples, etc.) hitting rigid objects (like walls, floors, etc.) Use a "happy" bouncy ball and a "sad" non-bouncy ball to attempt to knock over a block to examine the change in velocity	Pre Test on Conservations Laws Lab Activities- Types of Collisions → Qualitative analysis of different types of collisions. Develop model, predict and test. Students make conclusion of dependence type of collisions, mass and resulting velocities. Conservation of Momentum → Quantitative analysis of collisions. Using models developed from types of collisions and patterns from quantitative data collected, develop law of conservation. Predict and Test for objects with different motions. Conservation of Momentum at Subatomic Level→ Use event slides from Fermi Laboratories and conservation of momentum to determine the momentum of the neutrino and the mass of the top quark. Design a CSI project for the students where they utilize physics to calculate

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
How can impulse and momentum be calculated to solve for the unknown variable?	Graphically determine impulse on a force and time graph. Mathematically determine impulse, force, time, momentum and velocity.	Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html Videos (internet, DVD and VHS accessible) to watch frame by frame or regular speed to view collisions between objects PUM (Physics Uniting Math) Activities for Conservation Laws	and momentum is greater for the "happy" rather than the sad" Discussion of current research of subatomic particle collisions and findings → Particle Accelerators (for proton-proton collisions) at Fermi Labs and CERN Problem solving with collisions Conservation Bar Charts (Momentum)	the car's motion (velocity, direction, etc) at accident scenes. Quizzes on types of collisions, calculating momentum, relationships between mass, inertia, force, velocity, and momentum, ranking and comparing momentums, using conservation of momentum and conservation bar charts Homework (collected, checked, gone over in class) Check students' use of vocabulary and explanations throughout lessons Problem Solving and Board Work Closure- "What have I learned today and why do I believe it?" "ABC" cards "How does this relate to...?" Represent and Reason Jeopardy Questions "What still remains unclear?" Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Momentum AP Exam Sample Problems
What is the law of conservation of momentum and how does it apply to different collisions?	Recognize that momentum is conserved in a closed system- the total momentum before event is equal to the total momentum after event.			
What are the different types of collisions? Is energy always conserved in collisions?	Differentiate between the types of collisions based on conservation of momentum and energy and explain the resultant velocities.			
How can conservation of momentum be represented?	Demonstrate knowledge of the law of conservation in multiple representations including but not limited to mathematical, pictorial and graphical.			

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Essential Vocabulary:
systems, transfer, conservation, momentum, law of conservation of momentum, inelastic and elastic collisions, head-on and glancing collisions, impulse

Possible Projects: Egg Drop, CSI Momentum- car accident scene

Freehold Regional High School District
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Unit #7: Conservation Laws- Work & Energy

Enduring Understandings: Energy takes many forms; These forms can be grouped into types of energy that are associated with the motion of mass (kinetic energy), and types of energy associated with the position of mass and with energy fields (potential energy).
Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.
Energy is conserved in a closed system.
Simple machines can help by decreasing the force a human needs to exert in order to perform a task.

Essential Questions: What is the relationship between work and energy?
What is the law of conservation of energy and what does it mean?
How can conservation of energy in a system be represented physically and mathematically?
What are the different types of simple machines and how are they used?
What kind of advantages do simple machines have?
What is the difference between efficiency and mechanical advantage?

Unit Goal: Students will understand that energy and momentum are conserved within a system.
Duration of Unit: 2 weeks
NJCCCS: 5.2 (D1, 4)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
 What is a system and what is the importance of identifying the objects in a given system and its initial and final energy states? What is work and how it is related to energy? What transfers energy in and out of a system?	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed. Identify the system and its initial and final states. Calculate work and to distinguish when it is being done on a system as opposed to when it is being done by a system. Relate the definition of work in a scientific setting and differentiate it from non-scientific connotations. Examine work as a scalar product	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales or various sorts, and glassware. ESPECIALLY→putty (or objects that can be crushed and deformed), objects of similar shape but different mass, motion sensors (or way of measuring velocity of an object), staircase/bleacher steps, pulleys (single, double, triple), levers (1st, 2nd, and 3rd class), ramps of adjustable inclination, force sensors (or spring scales), masses, low friction carts. Teacher and student editions of text approved by the district	Observations of various massed objects falling from different heights on putty. Compare and contrast the resulting shape of putty when constant mass is dropped from increasing heights from when it was just sitting on top of putty. (Can be replaced with weak paper cups.) Keep the dropping height constant and change mass. Compare and contrast the shape of putty. Measure the mass and velocity of the object and calculate linear kinetic energy. Chart of different types of energy (both kinetic and potential) and when, where and for what	Lab Activities- Potential and Kinetic Energy → Qualitative analysis of different types of energy. Develop model, predict and test. Students make conclusion of dependence type of energy, mass, height, and resulting velocities. Conservation of Energy→ Quantitative analysis of work and energy. Students do work to get an object to some height, Predict and Test. Collect data to calculate potential and kinetic energy at max height. Allow object to fall through sensor for objects, collect data from sensor (velocity) and calculate potential and kinetic energy at new height. Students conclude whether energy was conserved in the system

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	between the external force exerted on a system and the displacement it was exerted over. Graphically determine work on a force and displacement graph.	Scientific/ graphing calculator Possibly a math book for algebraic and calculus reference and example problems.	situations each apply Draw energy bar charts for rollercoaster ride, apple falling from tree branch, soccer ball rolling down a hill, etc.	and if this energy is equal to the work added to the system by the students. Predict & Test Lab, using a spring and a ring stand, stretch the spring while on the ring stand, predict the potential energy the stretched spring has to predict the height it will go to.
What is the relationship between kinetic and potential energy? What are different types of potential energy? What are the different forms of energy?	Derive expressions for gravitational potential energy, kinetic energy, and spring potential energy. Demonstrate knowledge of the relationship kinetic and potential energy using mathematical, pictorial and graphical representations Differentiate the different forms of energy and give real life examples of each.	Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html	Work in different directions- emphasize that work is done ONLY when there is force exerted over a distance (location must change) Real life applications: Show real simple machines in class. Discuss how each machine is used and what its main function.	Power→ Students collect data (time, distance/height, and force/weight) for walking up steps. Calculate power. Compare and contrast power of different students. Answer questions regarding power, force, time and 'strength' of students.
What is the difference between an energy transformation and an energy transfer? What is the difference between a transfer of energy by a constant force and a varying force?	Differentiate between energy transformations and energy transference and demonstrate this knowledge with real world applications.	Videos (internet, DVD and VHS accessible) to watch frame by frame or regular speed PUM (Physics Uniting Math) Activities for Conservation Laws (Energy Module)	Draw simple machines of different types and label locations of input and output forces Take apart complex machines and identify the simple machines that make up the larger machine Show examples of Rube Goldberg Machines (multiple energy transformations and transfers with use of simple machines to perform simple tasks in a complex way)	Pulley Systems → Application of simple machines and work concepts. Calculate and compare input and output forces and distances. Calculate efficiency of the machine Ramps (Incline Planes)→ Application of simple machines and work concepts. Calculate and compare input and output forces and distances. Calculate the efficiency of the machine
When do conservation laws apply to changing systems? How does energy conservation relate to collisions?	Apply the law of conservation of energy to describe changing systems Understand the work-energy theorem Explain the law of conservation of energy and how energy is conserved only in a closed system.			Levers→ Application of simple machines and work concepts. Calculate and compare input and output forces and distance. Calculate efficiency of the machine.
What is power and how is it calculated?	Calculate power recognize that it is a change in energy or work within a given time frame.			
What is the difference between work done and effort?	Differentiate between work (force exerted over a distance) and effort (the actual force exerted by person)			Quizzes on types of energy, calculating energy, work and power, work-energy theorem, using conservation of energy and conservation bar charts, types of simple machine and their uses, calculating power, mechanical
Why are simple machines useful?	Recognize that simple machines do not decrease the amount of work but instead decrease the amount of force			

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	a person needs to exert to get the work done by increasing the distance the force is exerted over.			advantage, and efficiency Homework (collected, checked, gone over in class) Check students' use of vocabulary and explanations throughout lessons Problem Solving and Board Work Closure- "What have I learned today and why do I believe it?" Represent and Reason Jeopardy Questions Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Work and Energy UNIT TEST- Conservation Laws AP Exam Sample Problems
What are the basic types of simple machines?	Identify and define the basic types of machines, how they are used and give examples of each			
How can you categorize simple machines?	Categorize simple machines based upon their functions and uses and describe where the input and output forces are located.			
What are the different types/classes of levers and where are the forces and fulcrums located in each in each?	Differentiate between the 3 classes of levers and give examples of each			
How can you calculate mechanical efficiency?	Calculate the efficiency of a simple machine based on work ratio, power ratios and mechanical advantage ratios.			
What is the difference between ideal and actual mechanical advantage and how can you account for any differences?	Calculate mechanical advantage and account for differences between ideal and actual values. Use simple machines, like pulleys and ramps, to determine actual and ideal mechanical advantages			

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Essential Vocabulary:
Work, energy, potential (gravitational, elastic, electrostatic), kinetic (linear, rotational), mechanical, nuclear energy, electrical energy, sound, light, chemical energy, internal energy, systems, power, efficiency, transfer, transform, conservation, law of conservation of energy, simple machine (levers, wheel & axle, pulley, wedge, incline plane, screw), mechanical advantage (ideal and actual), efficiency, effort, input and output distances, and forces

Possible Projects: Roller Coasters, Rube Goldberg Machine

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Unit #8: Thermodynamics

Enduring Understanding: The motion of particles that make up an object affect that object's temperature, internal energy and its ability to heat or be heated.
Essential Questions: What is the difference between heat, temperature, and internal/thermal energy?
What are the basic laws of thermodynamics?
Unit Goal: Students will gain an understanding of how energy affects the internal motion of an object.
Duration of Unit: 2 weeks
NJCCCS: 5.2 (C)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales of various sorts, and glassware. ESPECIALLY→	Analogies between students with marbles and energy of particles in a system Thermal Energy→ Students all receive 3 marbles (or small identical objects) and play "Rock-Paper-Scissors" with other students as they walk around the room. Winner of game gets to take 1 marble from loser and both move on. Students with less marbles win ties.	Pre- Test on Heat, Temperature, & Energy Lab Activity Heat Bridge→ Students will use different materials to heat one beaker of water with another beaker of water that has a much higher initial temperature. Students calculate the rate at which the first beaker heats up and what energy is lost to the environment.
What does the word "heat" mean? What is temperature? How is temperature related to energy?	Define and differentiate between heat, temperature and thermal energy	Thermometers (or temperature probes/sensors), hotplates or Bunsen burners,		
How do you increase the temperature of a system? What does an object's thermal energy depend on?	Recognize that a system can absorb or give up energy by heating in order for work to be done on or by the system, and that work done on or by a system can result in energy transfer by heating. Compute the amount of work done during a thermodynamic process.	Teacher and student editions of text approved by the district Scientific/ graphing calculator	Students calculate total energy (marbles) in system (classroom) and average kinetic energy-temperature (marbles per student) before and after playing several rounds of Rock-Paper-Scissors	Quizzes on differences between heat, energy, and temperature, difference between isothermal, isovolumetric and adiabatic processes, first and second laws of thermodynamics, conservation
What is conduction? What is convection? How are convection and conduction different? What is radiant energy? What kind of heating is global warming?	Differentiate between the convection, conduction and absorption and the emission of radiant energy. Give examples of scenarios using each of the difference ways to heat a system.	Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet	Heating→ Teacher can be on one side of classroom adding marbles (heating) to students (particles) who come near. Students recalculate total energy and average kinetic energy	Homework (collected, checked, gone over in class) Check students' use of vocabulary and explanations throughout lessons
How is temperature related to volume? What is the difference between	Distinguish between isovolumetric, isothermal, and adiabatic thermodynamic processes.	Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_phy	Computer Applets from PhET (University of Colorado at Boulder) where students can adjust variables and limits and view resulting changes in temperature	Problem Solving and Board Work Closure- "What have I learned today and

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
isovolumetric, isothermic, and adiabatic processes? ——— What is the first law of thermodynamics? How can the change in energy be found using the first law of thermodynamics? What are some examples of cyclic processes? ——— What is the second law of thermodynamics? What happens when a system of one temperature is exposed to a system with a different temperature? What is equilibrium? What is a heat engine and how does it work? ——— What is entropy? How does entropy relate to conservation laws?	——— Illustrate how the first law of thermodynamics is a statement of energy conservation. Calculate heat, work, and the change in internal energy by applying the first law of thermodynamics. Apply the first law of thermodynamics to describe cyclic processes. ——— Recognize why the second law of thermodynamics requires two bodies at different temperatures for work to be done. Calculate the efficiency of a heat engine. ——— Relate the disorder of a system to its ability to do work or transfer energy by heating. Identify systems with high and low entropy. Distinguish between entropy changes within systems and the entropy change for the universe as a whole.	sics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html	and internal thermal energy. Real world applications of thermodynamics→ engines, refrigerators, expansion of metals (extra space between bridge joints), solar energy Graphs of different thermodynamic processes Analogy of teenage bed room being left to itself to entropy	why do I believe it?" "ABC" cards "How does this relate to...?" Represent and Reason Jeopardy Questions "What still remains unclear?" Write your own physics problem Weekly (or daily) Journal Writing (reflection of lessons and learning) Post Test on Heat, Temperature, & Energy AP Exam Sample Problems

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Essential Vocabulary:
absolute zero, calorie, Celsius scale, Fahrenheit scale, heat, internal energy, thermal energy, Kelvin scale, kilocalorie, specific heat capacity, temperature, thermal contact, thermal equilibrium, thermostat, conduction, conductor, convection, greenhouse effect, insulator, Newton's law of cooling, radiant energy, radiation, terrestrial radiation, boiling, condensation, equilibrium, evaporation, freezing, phase, relative humidity, saturated

Possible Projects: Build a Sterling Engine, Design/Create a Chapter for Textbook (including physics pictures, important terms, descriptions, objectives, review questions)

Freehold Regional High School District
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Unit #9: Waves & Wave Motion

Enduring Understanding: Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.
Simple harmonic motion is a transform of energy within a system such as an oscillating spring or a pendulum

Essential Questions: What constitutes something that is in simple harmonic motion?
How do waves transfer energy without transferring matter?
How can waves be categorized? What do these types of waves depend on?
What are the characteristics of all waves?

Unit Goal: Students will understand the characteristics and properties of wave and wave motion.
Duration of Unit: 2 weeks
NJCCCS: 5.2 (D1, 4, E1-4)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
What conditions are necessary for an object to be in simple harmonic motion? What is simple harmonic motion and how does it differ from periodic motion? How can the spring constant be found using Hooke's Law? What is the relationship between the restoring force and displacement? How are frequency and period related? How can the frequency and period be calculated using simple harmonic motion?	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed. Identify the conditions of simple harmonic motion. Explain how force, velocity, and acceleration change as an object vibrates with simple harmonic motion. Calculate the spring's restoring force and spring constant using Hooke's law. Identify the amplitude of vibration. Recognize the relationship between period and frequency. Calculate the period and frequency of an object vibrating with simple harmonic motion. Apply energy to simple harmonic	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales of various sorts, and glassware. ESPECIALLY→ (SHM) springs with different spring constants, masses, pendulum bobs (identical and different sizes and masses), string, support rods, PASCO photogate sensors and interface, protractors Teacher and student editions of text approved by the district Scientific/ graphing calculator Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1	Observations of a spring's stretch when different masses are hung from it. Class plots force vs. stretch and analyze data. Slope of the line is spring constant. Predict what the stretch should be for a new mass. Test. Data of period of pendulum swing at different locations on the Earth for one meter long pendulum: graph. PhET Applets for oscillating springs Introduce new potential energy→ Elastic Potential Energy Use Energy Bar Charts and make scenarios that will include kinetic energy, gravitational potential and elastic potential energy Energy transforms for a swinging pendulum	Pre Test on Mechanical Waves and Wave Motion Lab Activities- Simple Harmonic Motions→ Hooke's Law- Students collect data and find patterns to determine factors that affect the period of vibration. Present findings to class Pendulums- Students collect data for one variable of possible factor that affects period of pendulum swing. White Board presentation to class. Class conclusion as to which factors affect period of pendulum swing Quizzes on Hooke's Law, simple harmonic motion, pendulums, and factors that affect period of oscillation/vibration Homework (collected, checked, gone over in class)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
How can energy be used to explain simple harmonic motion?	motions and draw energy bar charts with elastic potential energy	www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html Videos (internet, DVD and VHS accessible) to watch frame by frame or regular speed to view objects in simple harmonic motion PUM (Physics Uniting Math) Activities for Conservation Laws (Energy Module)		Check students' use of vocabulary and explanations throughout lessons Problem Solving and Board Work Closure- "What have I learned today and why do I believe it?" "ABC" cards "How does this relate to...?" Represent and Reason Jeopardy Questions "What still remains unclear?" Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Simple Harmonic Motion AP Exam Sample Problems
______ What are the parts of a wave? ______ What is the difference between a "snapshot" wave and a particle's periodic wave motion? ______ What is the difference between a pulse, a periodic wave, and a traveling wave? What is the difference between longitudinal and transverse waves? How many ways can a wave be	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed. ______ Draw and label the parts of a wave. ______ Distinguish local particle vibrations from overall wave motion. Plot and analyze displacement vs. position and displacement vs. time graphs ______ Differentiate between pulse waves, traveling waves, and periodic waves. Compare and contrast longitudinal and transverse waves. Interpret waveforms of transverse	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales of various sorts, and glassware. ESPECIALLY→ extra long slinkies, ropes (about 3-5 meters worth), wave tables/ripple tanks (or teacher demonstration projector wave table) with accessories for reflection, refraction, diffraction, interference Teacher and student editions of text approved by the district Scientific/ graphing calculator Possibly a math book for algebraic and calculus reference and example problems.	Observations of wave motion on rope (transverse wave) Observations of wave motion on slinky (longitudinal wave) Observations of wave motion in water (mechanical waves) Draw diagrams of wave using sine waves, compressions and rarefactions, wave fronts and rays Graph particle motion over time and compare to all particles on oscillating object for one instance of time. Overhead Projector and transparencies of interfering wave fronts to find relationships between spacing of sources and wavelengths	Pre Test on Mechanical Waves and Wave Motion Lab Activities- Ripple Tanks→ Use ripple tanks to observe characteristics of mechanical waves (like water waves) Answer questions about different characteristics Speed of a Wave in a String→ Students calculate the speed of a wave in a string Quizzes on parts of a wave, different types of waves, characteristics of waves, speed of a wave, interpreting and making graphs, drawing the resulting wave from two interference waves, standing waves

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
categorized? What does the categorizing depend on?	and longitudinal waves.	Access to Computers and Internet Internet resources: islephysics.net	Observations of standing waves from taught string attached to adjustable frequency driver.	Homework (collected, checked, gone over in class)
How can the speed of a wave be calculated?	Apply the relationship among wave speed, frequency, and wavelength to solve problems.	paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html		Check students' use of vocabulary and explanations throughout lessons
What are the characteristics of a wave? What is reflection? What is refraction? What is diffraction? What is interference?	Identify the characteristics of waves (reflection, refraction, diffraction and interference) Predict when a reflected wave will be inverted.	http://www.phy.mtu.edu/links/Interactive_Physics.html Videos (internet, DVD and VHS accessible) to watch frame by frame or regular speed		Problem Solving and Board Work Closure- "What have I learned today and why do I believe it?"
How does energy relate to amplitude of a wave? How can you determine the amplitude of a wave from a graph of displacement vs. time?	Relate energy and amplitude. Interpret different types of graphs	PUM (Physics Uniting Math) Activities for Waves		"ABC" cards "How does this relate to...?" Represent and Reason Jeopardy Questions "What still remains unclear?"
How can a resulting wave be distinguished from two interfering waves? How do waves interfere with each other? What conditions are necessary for a standing wave to be produced? What are the different parts of a standing wave? How do the parts of the standing wave relate to the parts of a traveling or pulse wave?	Apply the superposition principle. Differentiate between constructive and destructive interference. Predict whether specific traveling waves will produce a standing wave. Identify nodes and antinodes of a standing wave.			Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Mechanical Waves AP Exam Sample Problems

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Essential Vocabulary:
Wave fronts, rays, incoming waves, outgoing, angle of incidence, angle of reflection, angle of refraction, spread angle, amplitude, antinode, constructive interference, crest, destructive interference, frequency, longitudinal wave, mechanical wave, medium, node, period, periodic wave, pulse wave, simple harmonic motion, standing wave, transverse wave, trough, wavelength, compression, rarefaction, resonance

Possible Projects: Student Made Wave Demonstration Videos

Freehold Regional High School District
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Unit #10: Sound

Enduring Understanding: Sound is a transfer of energy through a medium in the form of a compression wave.
Essential Questions: What is sound?
What is the relationship between perceived qualities and physical quantities?
What is the Doppler Effect?
Unit Goal: Students will understand the characteristics and properties of sound.
Duration of Unit: 2 weeks
NJCCCS: 5.2 (D4, E1)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
  How are sound waves produced? What type of wave is sound? What factors affect the speed of sound? What direction does sound wave travel? How do properties of waves relate to perceived aspects of sound? How are volume, relative intensity, intensity, energy, and amplitude related? What is resonance and how does it occur? How can the harmonics of a note be calculated? What is an octave? What is the difference between an	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed. Explain how sound waves are produced and transmitted. Compare the speed of sound in various media. Relate plane waves to spherical waves. Relate frequency to pitch. Relate harmonics and timbre. Calculate the intensity of sound waves. Relate intensity, decibel level, and perceived loudness. Explain how the human ear works and identify its parts Explain why resonance occurs. Differentiate between the harmonic series of open and closed pipes. Calculate the harmonics of a	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales of various sorts, and glassware. ESPECIALLY→ decibel meters, speakers, microphones, musical instruments (stringed instrument, wind instrument, percussion), open ended and closed ended tubes, tuning forks, resonance boxes, Doppler ball Teacher and student editions of text approved by the district Scientific/ graphing calculator Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/In	Develop models for sound (type of waves) "Poor Mans Telephone" (cans at the end of long string) Give students "hearing test" to allow students to evaluate their audible frequency range (Audacity Freeware) Real world examples of Threshold of Hearing and Threshold of Pain Demonstrations of different musical instruments (plucking strings and rubber bands, banging on percussion type cans with membranes, wind chimes, Helmzholtz Resonators/blowing into soda bottle, slide whistle) Singing wine class and resonance, video of Tacoma Narrows Bridge collapse Twirl A Tune tubes, rotating sound source, audio of a car driving by while honking horn.	Lab Activities- Speed of Sound→ *requires nice weather* Students measure the time for sound to travel across a football field. Graph distance vs time for different distances. Compare to theoretical speed of sound based on temperature that day. Speed of Sound→ Alternate activity Find resonating length for tube when tuning fork is brought near opening. Use length to calculate the wavelength, and use wavelength and frequency to calculate experimental speed of sound. Compare to theoretical based on temperature in room. Quizzes on sound waves, relation of properties of waves to perceived aspects of sound, Doppler effect, resonance, musical instruments Homework (collected, checked, gone over in class) Check students' use of vocabulary and explanations throughout lessons

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
open ended pipe and closed ended pipe? What are the laws of strings? _______________ What are beats and how can you calculate them? _______________ What is the Doppler Effect? What conditions are necessary for an observer to experience the Doppler Effect?	vibrating string and of open and closed pipes. _______________ Relate the frequency difference between two waves to the number of beats heard per second. _______________ Recognize the Doppler Effect, and determine the direction of a frequency shift when there is relative motion between a source and an observer.	teractive_Physics.html Videos (internet, DVD and VHS accessible) Audacity Freeware or comparable audio files for frequency ranges and sound analysis		Problem Solving and Board Work Closure- "What have I learned today and why do I believe it?" "ABC" cards "How does this relate to...?" Represent and Reason Jeopardy Questions "What still remains unclear?" Weekly (or daily) Journal Writing (reflection of lessons and learning) UNIT TEST- Mechanical Waves and Wave Motion AP Exam Sample Problems

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Essential Vocabulary:
Beat, compression, decibel level, Doppler effect, fundamental frequency, harmonic series, intensity, pitch, rarefaction, resonance, timbre

Possible Projects: Make a Musical Instrument

Freehold Regional High School District
M/S AP Physics B

Unit #11: Electrostatics

Enduring Understandings: Charged bodies can attract or repel each other with a force that depends upon the size and nature of the charges and the distance between them and that electric forces play an important role in explaining the structure and properties of matter.
Electromagnetic and gravitational forces can be used to produce energy by causing physical changes and relate the amount of energy produced to the nature and relative strength of the force.
Intrinsic properties of matter are: it has mass, takes up space, made of smaller moving parts (atoms and other subatomic particles), and has charges.

Essential Questions: How many charges are there and what part of the atom is charged?
What are relationship between charge, force between charges and distance?
How can electric interactions be represented physically and mathematically?
What does electrical potential energy depend on?

Unit Goal: Students will gain an understanding of electromagnetic forces and how they affect matter and energy.
Duration of Unit: 3 weeks
NJCCCS: 5.2 (A1, D1, 4, E3, 4)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales of various sorts, and glassware. ESPECIALLY→ Rods of different materials (wood, metal, plastic, glass, foam insulating tubes), different fabrics (plastic, silk, wool/felt, fur), electroscopes, Wimshurst machine, Van de Graaff generator. Teacher and student editions of text approved by the district Scientific/ graphing calculator Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net	Observations of materials rubbed with different materials reacting with other materials rubbed with similar materials, different materials and the material used to rub. Transparent Tape being pulled off other tape, being pulled off table, and their reactions to each other. Using electroscopes to show that an object is charged and different ways to charge an object (such as an electroscope) Discuss models of atoms to figure out the "positive and negative" charged parts Polarity of water, although water molecule has a zero net charge Micro and macroscopic views of objects with charges and how the	Electric Concepts Survey (Preliminary) Lab Activities- Interactions between Charged objects→ Students collect data and find patterns. Students develop models, make predictions and test. Revise model if necessary Testing Experiment→ Are charges magnetic poles? Use rubbed objects to see if it attracts and repels the ends of magnets. Use magnets to see if it attracts and repels other magnets Students present findings to class Charging an Electroscope→ Students use rubbed objects to charge an electroscope and use knowledge of conductors and insulators to figure out how to pass the charge to another
How many different types of charges are there? How can you tell if an object is charged? What does it mean if an object is neutral? What subatomic particles are associated with charge? What are the different interactions that can occur between objects with charge?	Understand the basic properties of electric charge.			
How can an object be charged? How do you know if an object is charged?	Distinguish between charging by contact and charging by polarization/induction.			
	Differentiate between conductors and insulators.			

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
What is a conductor and how is it different from an insulator? How is the electric force similar to the gravitational force? How is it different? How can you calculate the electric force using Coulomb's Law? How can you represent the net force on an object with charge? What is an electric field? What conditions are necessary for a field to exist?	Identify the four properties associated with a conductor in electrostatic equilibrium. Calculate electric force using Coulomb's law. Compare electric force with gravitational force. Discriminate between types of interactions based on charges and how these differ from those based upon mass. Apply the superposition principle to find the resultant force on a charge and to find the position at which the net force on a charge is zero. Include electric forces in freebody diagrams Draw and interpret electric field lines.	paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html Videos (internet, DVD and VHS accessible) PUM (Physics Uniting Math) Activities for Electrostatics	charge can move within the material Graphing the relationship between force, charge and distance Historical importance of charges (why we focus on positive charges) Benjamin Franklin and electrostatic research and inventions→ don't have to be called "negative" and "positive". Analogies between gravitational force and electric force Draw electric field lines	electroscope Quizzes on ways to charge, types of charges and interactions, electric force, conductors and insulators, electric field and field lines. Homework (collected, checked, gone over in class) Check students' use of vocabulary and explanations throughout lessons Problem Solving and Board Work Closure- "What have I learned today and why do I believe it?" "ABC" cards "How does this relate to...?" Represent and Reason Jeopardy Questions "What still remains unclear?" Write your own physics problem Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Electrostatics AP Exam Sample Problems
What is electric potential energy? How is electric potential energy	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed. Define electrical potential energy. Compare and contrast electrical potential energy with gravitational potential energy.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales or various sorts, and glassware. ESPECIALLY→ Van de Graaff generators, florescent light bulb, voltmeters (or multimeters), capacitors Teacher and student editions of	Analogies between electric potential energy and gravitational potential energy (and elastic potential energy) Draw and use equipotential lines to represent situation and to help differentiate between electric potential energy, potential difference and voltage	Lab Activity Building Capacitors→ Students build their own capacitor using plastic cups, aluminum foil and a source of charge (comb through hair). Test to see if it works- When students complete the circuit, they will get small shock. Quizzes on electric potential

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
similar to gravitational potential energy and elastic potential energy? What is the difference between electric potential energy, potential difference and voltage? How can you calculate the electric potential energy of a charged object? What is a capacitor? Why are capacitors used? How can you calculate the value of an object's capacitance? How can you calculate the amount of energy stored in a capacitor?	Compute the electrical potential energy for various charge distributions. Distinguish between electrical potential energy, voltage, and potential difference. Compute the electric potential for various charge distributions. Relate capacitance to the storage of electrical potential energy in the form of separated charges. Calculate the capacitance of various devices. Calculate the energy stored in a capacitor.	text approved by the district Scientific/ graphing calculator Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html Videos (internet, DVD and VHS accessible)	Energy Bar Charts Observations of florescent light bulb working when it is held perpendicular to equipotential lines (and parallel to field lines), not working when held parallel to equipotential lines (and perpendicular to field lines) Real world usage of capacitors	energy, voltage, capacitors Homework (collected, checked, gone over in class) Check students' use of vocabulary and explanations throughout lessons Problem Solving and Board Work Closure- "What have I learned today and why do I believe it?" "ABC" cards "How does this relate to...?" Represent and Reason Jeopardy Questions "What still remains unclear?" Write your own physics problem Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Electric Potential Electric Concepts Survey (Post) AP Exam Sample Problems

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Essential Vocabulary:
Conductor, electric field, electric field lines, induction, insulator, electric potential, electrical potential energy, potential difference, superconductor.

Possible Projects: Build an Electroscope

Freehold Regional High School District
M/S AP Physics B

Unit #12: Electricity

Enduring Understandings: Students will understand that there is a relationship and what the relationship is between voltage, resistance, current and power.
Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced.
Essential Questions: How are current, voltage, and resistance related?
What are the basic electrical circuit components and what are their applications?
How are circuits in series different from circuits in parallel?
Unit Goal: Students will gain an understanding of electromagnetic forces and how they affect matter and energy.
Duration of Unit: 2 weeks
NJCCCS: 5.2 (A1, D1, 4, E1-4)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	ALL: Reinforce and continuously use scientific method and critical thinking processes.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales or various sorts, and glassware.	History of AC and DC current (Thomas Edison vs. WestingHouse)	Lab Activities Discovering Ohm's Law→ Student plot data "collected by Georg Ohm" and find relationships between current, resistance and voltage
What is current? What is electron flow? How do electrons move through a material? What is the difference between direct current and alternating current?	Describe the basic properties of electric current. Solve problems relating current, charge, and time. Differentiate between direct current and alternating current.	ESPECIALLY→ Batteries (or source), wires with clips, resistors (of different resistance), multimeters, circuit boards, light bulbs (mini or holiday lights)	Analogy of current to water flow Historical importance of current as positive charge movement (instead of negative electron flow)	Testing Experiment→ Students make predictions using Ohm's Law and set up circuit (applet or actual). Students measure the current through wire for different voltages and resistance and make conclusions based on results.
What is Ohm's Law and how can it be used to solve for unknown variable? What is the relationship between current and resistance? Current and voltage?	Calculate resistance, current, and potential difference using the definition of resistance.	Teacher and student editions of text approved by the district Scientific/ graphing calculator Possibly a math book for algebraic and calculus reference and example problems.	Graphing relationship between current and resistance, current and voltage Calculating energy efficiency, energy consumption, and energy cost for different appliances	Quizzes on current and resistance, Ohm's Law, energy usage, power, circuits, series vs. parallel, total and component voltage, current and resistance.
What makes a material resistive to the movement of charges? What are superconductors and why can't we use them in everyday circuitry?	Distinguish between ohmic and non-ohmic materials. Know what factors affect resistance. Describe what is unique about superconductors.	Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu	PhET Applet: Direct Current Circuit Kit can be used if you do not have access to circuit boards and circuit parts. Drawing of circuits both pictorially and schematically	Homework (collected, checked, gone over in class)
What is electric power? How is power related to current and voltage?	Relate electric power to the rate at which electrical energy is converted to other forms of energy. Calculate electric power.	phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/In		Check students' use of vocabulary and explanations throughout lessons Problem Solving and Board Work

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
Why is it important to turn off your electric appliances when they are not in use? How much energy is being used by a particular appliance? How much money and energy is wasted when you leave your tv, computer, charger, etc. on over night?	Calculate the cost of running electrical appliances.	teractive_Physics.html Videos (internet, DVD and VHS accessible)		Closure- "What have I learned today and why do I believe it?" "ABC" cards "How does this relate to...?" Represent and Reason Jeopardy Questions "What still remains unclear?" Write your own physics problem Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Electricity and Circuits AP Exam Sample Problems
How can you represent a circuit? When is a circuit complete?	Interpret and construct circuit diagrams. Identify circuits as open or closed.			
What is the total potential difference when using multiple sources? What is the total resistance of a circuit? What is the total current through the circuit? How does the set up of the circuit affect the total resistance, total voltage and total current of the circuit as a whole and for sections? What is the difference between components in parallel and components in series?	Deduce the potential difference across the circuit load, given the potential difference across the battery's terminals. Calculate the equivalent resistance for a circuit of resistors in series, and find the current in and potential difference across each resistor in the circuit. Calculate the equivalent resistance for a circuit of resistors in parallel, and find the current in and potential difference across each resistor in the circuit.			
Which is used in household circuitry: parallel or series? Why?	Determine which type of set up (parallel or series) should be used in different situations.			

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Essential Vocabulary:
potential difference, current, voltage, resistance, superconductor, electric circuit, resistors, batteries, direct current (DC), electromotive force (emf), parallel, schematic diagram, series, alternating current (AC)

Possible Projects: Build an Circuit

Freehold Regional High School District
M/S AP Physics B

Unit #13: Electromagnetism

Enduring Understandings: A change in electric field will result in a magnetic field and a change in magnetic field will result in an electric field.
The electromagnetic spectrum encompasses more than the visible part of the spectrum

Essential Questions: What are magnets and how can you determine if something has magnetic properties?
What is the relationship between an electric current and a magnetic field?
What is necessary in order to induce a magnetic field? An electric field?
How are electromagnetic oscillations categorized?

Unit Goal: Students will gain an understanding of electromagnetic forces and how they affect matter and energy.
Duration of Unit: 3 weeks
NJCCCS: 5.2 (A1, D1, 4, E1-4)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
 ――――― How are magnets similar to objects with net charge? How are they different? How can you determine the polarity of a magnet? What are magnetic domains? What does the magnetic domain depend on? What is the magnetic field? How can magnetic field lines be used to find the poles of a magnet? ――――― How do we know that the Earth is a giant magnet?	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed. ――――― For given situations, predict whether magnets will repel or attract each other. Describe the force between two magnetic poles Explain magnetism in terms of the domain theory of magnetism. Demonstrate knowledge of magnetic fields, their generations, orientation and effect upon charged, moving particles. Explain why some materials are magnetic and some are not. Describe four different categories of magnets. Describe and draw the magnetic field for a permanent magnet. ――――― Describe and draw the Earth's magnetic field. Determine the polarity of the Earth and compare the poles to	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales or various sorts, and glassware. ESPECIALLY→ Magnets (horseshoe, ceramic, neodymium, bar, lodestones), materials with magnetic properties, compasses, plastic swivel (or string to allow magnet to spin freely), magnetic field viewer (iron filings or other) galvonameter, hand crank generator Teacher and student editions of text approved by the district Scientific/ graphing calculator Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu	Observations of magnets interacting with other magnets (horseshoe, bar, neodymium, lodestones, ceramic, circular, fridge magnets) Magnetic interactions with ceramic ring magnets with opposite poles facing each other on a pencil (seem to levitate)→ associate distance between magnets and force, compare magnetic force to electric force and gravitational force Magnetic field viewer (iron fillings in clear plastic container or mini compasses brought next to magnet. Allow bar magnet to swivel freely on stand or from string, find the polarity of Earth. Discuss the Earth's polarity switching and possible problems that may occur (communication and navigation) Observations for Faraday's Law:	Lab Activities Eddy Current→ Students drop small object down vertically held copper pipe and time how long it takes for the object to appear at the bottom. Drop neodymium magnet down pipe and time how long it takes for the object to appear at the bottom. Students draw freebody diagrams for each case and compare the accelerations of the objects. Students use Faraday's and Lenz's Laws to explain their observations. Building Motors→ Students build a simple motor using battery, small coil of wire, and magnet. Students relate parts of simple motor to more complex electric motor and generators. Students answer questions on motors Quizzes on magnets and interactions, magnetic field lines, right hand rule, electromagnetic induction, electric motors, electromagnetic spectrum

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	the geographical poles. Give two examples of the effect of Earth's magnetic field.	wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html	place current carrying wire near compass and observe affects of wire on compass. Switch the direction of the current and make observations	Homework (collected, checked, gone over in class)
How is the Right Hand Rule used to figure out the direction of force, field, and current? What is the difference between the Right Hand Rule and the Left Hand Rule?	Use the right-hand rule to find the direction of the force on a charge moving through a magnetic field.	Videos (internet, DVD and VHS accessible)	Observations for Right Hand Rule: place a wire inside horseshoe magnet and observe direction of force (wire "jumps") when current is allowed to flow through wire.	Check students' use of vocabulary and explanations throughout lessons Problem Solving and Board Work Closure- "What have I learned today and why do I believe it?" "ABC" cards "How does this relate to…?" Represent and Reason Jeopardy Questions "What still remains unclear?" Write your own physics problem
How are the magnetic fields and electric fields related? What conditions are necessary for a current to be induced in a wire? What is an electromagnet and how is it made?	Understand and apply Faraday's Law to electromagnets Determine direction of the force on a wire carrying current in a magnetic field.		Observations for induced current: Coil of wire connected to galvonameter with magnet moving through coil (change in magnetic field induces change in electric field which produces current)	
What is Lenz's Law and how does it relate to Faraday's Law?	Determine the relationship between magnetic field and current Understand and apply Lenz's law to determine the direction of an induced current. Explain how a magnetic field can produce an electric current.		Application to electromagnets Historical figures: Michael Faraday, Heinrich Lenz Real world situations with motors, generators and transformers	Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Magnetism and Electromagnetic Induction
What is the electromotive force? What is an electric motor and how does it work? How is an electric motor similar to a generator? What is mutual and self inductance and how do they occur in circuits?	Describe how an electric motor and electric generators work as well as how electromagnetic induction works for devices such as doorbells and galvanometers. Describe how mutual inductance occurs in circuits. Describe how self inductance occurs in an electric circuit.		Uses of different parts of electromagnetic spectrum Calculation of speed of light	AP Exam Sample Problems
What types of radiation are considered part of the electromagnetic spectrum? How is electromagnetic radiation related to electromagnetic induction? How can electromagnetic radiation	Explain why electromagnetic waves are transverse waves. Describe how electromagnetic waves are produced. Identify how EM waves differ from each other. Identify the components of the			

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
be categorized in terms of waves?	electromagnetic spectrum. Describe some uses for radio waves and microwaves. Give examples of how infrared waves and visible light are important in your life. Explain how ultraviolet light, X rays, and gamma rays can be both helpful and harmful.			
What is the speed of light and what limitations are there to this speed?	Calculate the frequency or wavelength of electromagnetic radiation. Recognize that light has a finite speed.			

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Essential Vocabulary:
Conductor, electric field, electric field lines, induction, insulator, capacitance, electric potential, electrical potential energy, potenetial difference, current, drift velocity, resistance, superconductor, electric circuit, emf, parallel, schematic diagram, series, domain, magnetic field, solenoid, alternating current, back emf, electromagnetic induction, generator, mutual inductance, rms current, self-induction, transformer

Possible Projects: Build an Simple Motor, Make a Compass

Freehold Regional High School District
M/S AP Physics B

Unit #14: Light & Optics

Enduring Understandings: Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection).
To see an object, light from that object—emitted or scattered from it—must enter the eye.

Essential Questions: What are the characteristics of light?
What are different types of optical devices and how do they produce an image?
How can the location, size, orientation and type of image formed be predicted and represented physically and mathematically?

Unit Goal: Students will gain an understanding of light and how images are formed using different optical devices.

Duration of Unit: 4 weeks

NJCCCS: 5.2 (D4, E1)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
What is light? What characteristics does light have? What factors affect the brightness of a source of light? __________ When is reflected light considered specular and when is it considered diffuse? What is the law of reflection? How does the number of images depend on the angle between two plane mirrors? What is an image and how does it differ from an object/source of light? How can focal point be found using ray diagrams? What shapes can optical devices have and how does the shape affect the position, location, orientation and size of the image? What is the difference between real and virtual images? What is the difference between parabolic and spherical mirrors? What are the different types of optical devices and	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed. Understand the dual nature of light Describe reflection, refraction, diffraction, and interference. Explain how colors are part of white light and the combination of the colors makes white light. Describe diffraction and interference of light. Describe how the brightness of a light source is affected by distance. __________ Distinguish between specular and diffuse reflection of light. Apply the law of reflection for flat mirrors. Describe the nature of images formed by flat mirrors. Calculate distances and focal lengths using the mirror equation for concave and convex spherical mirrors. Draw ray diagrams to find the image distance and magnification for concave and convex spherical mirrors. Distinguish between real and virtual images. Describe how parabolic mirrors differ from spherical mirrors. Identify different optical devices and their uses.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales of various sorts, and glassware. ESPECIALLY→ Light sources, plane mirrors, curved mirrors, convex and concave lenses, Fresnel lenses, laser pointer, polarizing filters, color transparencies, prisms, diffraction grating, single and double slit slides, Teacher and student editions of text approved by the district Scientific/ graphing calculator Possibly a math book for algebraic and calculus reference and	History of Light- Change in models of light starting with ancient Greeks to modern day ideas Experiments to determine accurate model of light (both historical and ones that can be done in class) Drawing ray diagrams for different optical devices (pinhole cameras, plane mirrors, spherical mirrors, concave and convex lenses) Real world use of optical devices (projectors, microscopes, telescopes, glasses, filters) Color Wheel- primary colors in art compared to primary	Pre-Test on What is Light? Lab Activities- Images and multiple mirrors→ Students change the angle between plane mirrors from 0 to 180° and find relationship between number of images and angle Images formed by optical devices→ Students test models made for different optical devices and predictions made with ray diagrams Quizzes on models of light, reflection of light, mirrors, refraction of light, lenses, ray diagrams, color, polarization, interference and diffraction. Homework (collected, checked, gone over in class) Check students' use of vocabulary and

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
what characteristics of light do each use to produce images? What is Snell's Law? What is the difference between convex and concave lenses? How are colors related to light? What affects the observed color of an object? What is polarization? What characteristic of waves explains Young's Double Slit Experiment? What characteristics of light are supported by the wave model? What characteristics of light affect an image's resolution? What is a laser? What are the advantages of lasers over other light sources?	Recognize situations in which refraction will occur. Identify which direction light will bend when it passes from one medium to another. Solve problems using Snell's law. Use ray diagrams to find the position of an image produced by a converging or diverging lens, and identify the image as real or virtual. Solve problems using the thin-lens equation. Calculate the magnification of lenses. Describe the positioning of lenses in compound microscopes and refracting telescopes. Recognize how additive colors affect the color of light. Recognize how pigments affect the color of reflected light. Explain how linearly polarized light is formed and detected. Describe how light waves interfere with each other to produce bright and dark fringes. Identify the conditions required for interference to occur. Describe how light waves diffract around obstacles and produce bright and dark fringes. Describe how diffraction determines an optical instrument's ability to resolve images. Describe the properties of laser light. Explain how laser light has particular advantages in certain applications.	example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html Videos (internet, DVD and VHS accessible) PUM (Physics Uniting Math) Activities for Optics	colors in light Use of diffraction grating for spectroscopy Doppler Effect and light Lasers Explain why oil and bubbles have rainbow of colors that are secondary instead of primary colors Students discuss physics of rainbows Newton's Rings Apparatus	explanations throughout lessons Problem Solving and Board Work Closure- "What have I learned today and why do I believe it?" "ABC" cards "How does this relate to...?" Represent and Reason Jeopardy Questions "What still remains unclear?" Write your own physics problem Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Light and Optics Post Test- WHAT IS LIGHT? AP Exam Sample Problems

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Pertinent vocabulary necessary for the unit:
Angle of incidence, angle of reflection, concave spherical mirror, electromagnetic wave, linear polarization, real image, reflection, virtual image, chromatic aberration, critical angle, dispersion, index of refraction, lens, refraction, total internal reflection, coherence, diffraction, laser, order number, path difference, resolving power

Possible Projects: Student Role Play different Scientists and their theories and research of light, Build a Kaleidoscope (or other Optical Entertainment Device)

Freehold Regional High School District
M/S AP Physics B

Unit #15: Special and General Relativity

Enduring Understandings: The laws of physics apply to all reference frames.
Whether an observer is moving or not, the speed of light is constant.
Essential Questions: How does your frame of reference affect what you observe?
Unit Goals: All students will gain an understanding of how reference frame is used to explain and describe motion.
Duration of Unit: 1.5 weeks
NJCCCS: 5.2 (E1)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales of various sorts, and glassware. ESPECIALLY→ Objects of different mass, material that stretches (to show how mass 'warps' space-time), scissor arm coat rack (to show change in observed length of objects) Teacher and student editions of text approved by the district Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/phys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html Videos (internet, DVD and VHS accessible) to watch NOVAs (Elegant Universe, Einstein's Big Idea) biographies on Einstein, and other science shows on relativity. Books on Special Relativity and Einstein's papers	Observations of same event from different perspectives (different reference frames) The "Twin Paradox" Observations of how different mass objects affect fabric and other objects that come near large massed objects Pose questions about beginnings of the universe and how to explain unaccounted for mass in galaxies.	Quizzes on special and general relativity, reference frames, theories of black holes and beginnings of the universe. Homework (collected, checked, gone over in class) Check students' use of vocabulary and explanations throughout lessons Closure- "What have I learned today and why do I believe it?" "ABC" cards "How does this relate to...?" Represent and Reason Jeopardy Questions "What still remains unclear?" Write your own physics problem Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Special and General Relativity AP Exam Sample Problems
How are energy and mass related? What is the limit to a particle's speed and what particles can reach this speed?	Describe how matter and energy are interchangeable. Describe the fastest speed in the universe.			
What is antimatter?	Explain the concept of antimatter.			
How is special relativity different from general relativity? What does relativity mean? What role do reference frames play in relativity?	Describe some consequences of special relativity. Describe some of the consequences of general relativity.			
What is a black hole and what evidence is there for the existence of black holes?	Explain what a black hole is.			
What is the Big Bang Theory and what evidence is there to support this theory?	Explain what the Big Bang is.			

Suggestions on how to differentiate in this unit: • Facilitate group discussions to assess understanding among varying ability levels of students. • Provide more opportunities for advanced calculations and conversions for advanced students. • Draw and label diagrams to represent some of the data for visual learners. • Provide choice to students for group selections and roles in the group. • Provide modeling, where possible. • Provide real-life or cross-curricular connections to the material. • Provide time for revision of work when students show need.
Pertinent vocabulary necessary for the unit: reference frame, special relativity, general relativity, space-time, Lorenz transforms, time dilation, antiproton, positron, antimatter, dark matter, dark energy, *c*, Big Bang Theory, expansion, red shift
Possible Projects: Relativity Board Game

Freehold Regional High School District
M/S AP Physics B

Unit #16: Modern Physics

Enduring Understandings: Atoms are made of smaller particles (protons, electrons, and neutron) that remain bound to an atom due to nuclear and electric forces.
Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and thus can absorb and emit light only at wavelengths corresponding to these amounts.

Essential Questions: What are the models of an atom leading up to modern day and what is the currently accepted model?
What are the most common subatomic particles?
How do the subatomic particles stay in the atom and what does it mean if the atom changes over time?

Unit Goals: Students will gain an understanding that there are nuclear forces at the subatomic level and the interactions of these forces.
Duration of Unit: 1.5 weeks
NJCCCS: 5.2 (A, C, D, E)

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
	ALL: Reinforce and continuously use scientific method and critical thinking processes. Make predictions and design and perform experiments to test the models developed.	Variety of lab equipment that may be used throughout the year. Including but not limited to meter sticks, timers, scales or various sorts, and glassware. ESPECIALLY→ Diffraction grating (or spectrometers), tubes of different gases (different light sources), materials to build 3-D models of atoms, Teacher and student editions of text approved by the district Scientific/ graphing calculator Possibly a math book for algebraic and calculus reference and example problems. Access to Computers and Internet Internet resources: islephysics.net paer.rutgers.edu phet.colorado.edu wps.aw.com/aw_knight_physics_1 www.glenbrook.k12.il.us/gbssci/p	Historical timeline of modern physics and major modern physicists (atomic models, radioactive materials, dual nature of particles, quantum vs. classical physics) Information about particle accelerators (Fermi Labs, CERN…) and pictures of event slides, accelerator tunnels Information about nuclear reactors Posters of subatomic particles and their characteristics Posters of radioactive decay and resulting matter Posters of fusion and fission processes Relate electron cloud and probability to s-p-d-f orbitals (from chemistry)	Lab Activities Building Atomic Models→ Students work in groups on different models. Each group becomes an "expert" on their model and presents to class (or write a report) Spectra Lines→ Students observe spectra lines for different (unknown) elements and compare to spectra lines of known elements. Students identify the different unknowns. Students use absorption lines to categorize stars using their spectra Quizzes on dual nature of particles, atomic models and parts of an atom, spectra lines, radioactive decay and half-life, fission vs. fusion Homework (collected, checked, gone over in class) Check students' use of vocabulary and explanations throughout lessons Problem Solving and Board Work
What is quanta? Does the dual nature of particles apply to all particles? Why?	Recognize the dual nature for all particles - that an object can either be a wave or a particle and which it is depends on the observer Define and explain 'quanta' as packets of energy that can have both wave and particle characteristics			
Can classical mechanics be used to explain the interactions and motions of subatomic particles? Why?	Recognize that classical mechanics breaks down at subatomic levels and a new type of mechanics is required (Quantum)			
What are the different models of the atom? Which is the currently accepted model of an atom? What evidence is there to support this model?	Describe the different atomic models from Ancient Greek to Electron Cloud models Recognize that each element has a unique emission and absorption			

Guiding / Topical Questions	Content, Themes, Concepts, and Skills	Instructional Resources and Materials	Teaching Strategies	Assessment Strategies
What conditions are necessary for an atom's spectra to be observed? How can spectra be used to identify the elemental composition of objects (like stars)? What is the difference between absorption lines and emission lines in an atom's spectra?	spectrum. Explain atomic spectra using Bohr's model of the atom. Use spectra to figure out the composition of stars.	hys/phys.html http://www.phy.mtu.edu/links/Interactive_Physics.html Videos (internet, DVD and VHS accessible) to watch NOVAs (Elegant Universe, Einstein's Big Idea) biographies on Einstein, and other science shows on relativity. Books on modern physics and history of atomic models		Closure- "What have I learned today and why do I believe it?" "ABC" cards "How does this relate to...?" Represent and Reason Jeopardy Questions "What still remains unclear?" Write your own physics problem Weekly (or daily) Journal Writing (reflection of lessons and learning) Quest- Modern Physics AP Exam Sample Problems
What happens when an atom decays? What is an isotope? What is radioactive decay? What is the half-life of a particle?	Recognize that all things change with time Describe what happens when an atom decays Predict the result of an atom's decay Find an isotope's half-life			
What is the difference between fission and fusion? What conditions are necessary for fusion to take place? What are some of the dangers and benefits to nuclear reactors?	Differentiate between fusion and fission Explain fusion and the requirements for fusion to occur Identify pros and cons for nuclear reactors			

Suggestions on how to differentiate in this unit:

- Facilitate group discussions to assess understanding among varying ability levels of students.
- Provide more opportunities for advanced calculations and conversions for advanced students.
- Draw and label diagrams to represent some of the data for visual learners.
- Provide choice to students for group selections and roles in the group.
- Provide modeling, where possible.
- Provide real-life or cross-curricular connections to the material.
- Provide time for revision of work when students show need.

Pertinent vocabulary necessary for the unit:
duality, quantum, quanta, atom, electron, proton, neutron, nucleus, subatomic particles, photon, spectra lines, emission lines, absorption lines, elements, "Plum Pudding Model", "Planetary Model", "Electron Cloud Model", radioactive decay, half-life, isotope, fusion, fission, nuclear reactor

Possible Projects: Models of the Atom

REFERENCES AND RESOURCES

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AP College Board approved Syllabus for AP Physics B for FRHSD

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