

**Randolph Township Schools
Randolph High School**

Physics Curriculum

“Mathematical physics is in the first place physics and it could not exist without experimental investigations.”

- *Peter Bebye*

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Technology, Engineering, and Mathematics
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**Curriculum Developed:
July 2016**

**Date of Board Approval:
September 13, 2016**

Randolph Township Schools
Department of Science, Technology, Engineering, and Mathematics
Physics

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Randolph Township Schools

Mission Statement

We commit to inspiring and empowering all students in Randolph schools to reach their full potential as unique, responsible and educated members of a global society.

Randolph Township Schools Affirmative Action Statement

Equality and Equity in Curriculum

The Randolph Township School District ensures that the District's curriculum and instruction are aligned to the state's standards. The curriculum provides equity in instruction, educational programs and provides all students the opportunity to interact positively with others regardless of race, creed, color, national origin, ancestry, age, marital status, affectional or sexual orientation, gender, religion, disability or socioeconomic status.

N.J.A.C. 6A:7-1.7(b): Section 504, Rehabilitation Act of 1973; N.J.S.A. 10:5; Title IX, Education Amendments of 1972

RANDOLPH TOWNSHIP BOARD OF EDUCATION

EDUCATIONAL GOALS

VALUES IN EDUCATION

The statements represent the beliefs and values regarding our educational system. Education is the key to self-actualization, which is realized through achievement and self-respect. We believe our entire system must not only represent these values, but also demonstrate them in all that we do as a school system.

We believe:

- The needs of the child come first
- Mutual respect and trust are the cornerstones of a learning community
- The learning community consists of students, educators, parents, administrators, educational support personnel, the community and Board of Education members
- A successful learning community communicates honestly and openly in a non-threatening environment
- Members of our learning community have different needs at different times. There is openness to the challenge of meeting those needs in professional and supportive ways
- Assessment of professionals (i.e., educators, administrators and educational support personnel) is a dynamic process that requires review and revision based on evolving research, practices and experiences
- Development of desired capabilities comes in stages and is achieved through hard work, reflection and ongoing growth

Randolph Township Schools
Department of Science, Technology, Engineering, and Mathematics
Physics

Department of Science, Technology, Engineering, and Math Introduction

Randolph Township Schools is committed to excellence. We believe that all children are entitled to an education that will equip them to become productive citizens of the 21st century. We believe that an education grounded in the fundamental principles of science, technology, engineering, and math (STEM) will provide students with the skills and content necessary to become future leaders and lifelong learners.

A sound STEM education is grounded in the principles of inquiry, rigor, and relevance. Students will be actively engaged in learning as they use real-world STEM skills to construct knowledge. They will have ample opportunities to manipulate materials and solve problems in ways that are developmentally appropriate to their age. They will work in an environment that encourages them to take risks, think critically, build models, observe patterns, and recognize anomalies in those patterns. Students will be encouraged to ask questions, not just the “how” and the “what” of observed phenomena, but also the “why”. They will develop the ability, confidence, and motivation to succeed academically and personally.

STEM literacy requires understandings and habits of mind that enable students to make sense of how our world works. As described in Project 2061’s *Benchmarks in Science Literacy*, *The Standards for Technological Literacy*, and *Professional Standards for Teaching Mathematics*, literacy in these subject areas enables people to think critically and independently. Scientifically and technologically literate citizens deal sensibly with problems that involve mathematics, evidence, patterns, logical arguments, uncertainty, and problem-solving.

The Next Generation Science Standards are a multi-state effort to create new education standards that are "rich in content and practice, arranged in a coherent manner across disciplines and grades to provide all students an internationally benchmarked science education with an emphasis on engineering and technology. The purposes of the standards include developing greater interest in science among students so that more students choose to major in science and technology in college. Overall, the guidelines are intended to help students deeply understand core scientific concepts, to understand the scientific process of developing and testing ideas, and to have a greater ability to evaluate scientific evidence. Curricula based on the standards may cover fewer topics, but will go more deeply into specific topics, possibly using a case-study method and emphasizing critical thinking and primary investigation.

The standards were developed by a consortium of 26 states and by the [National Science Teachers Association](#), the [American Association for the Advancement of Science](#), the [National Research Council](#), and Achieve, a nonprofit organization that was also involved in developing math and English standards- The public was also invited to review the standards. The final draft of the standards was released in April 2013.

The NGSS are aligned to the New Jersey State Mathematics and English Language Arts Learning Standards (Common Core State Standards). When students are learning about science, they are also enhancing their skills in reading, writing and math.

Randolph Township Schools **Department of Science, Technology, Engineering, and Mathematics** **Physics**

Introduction

This course is an introductory course in algebra based physics. In this course students will:

- Understand the basic laws governing the universe and apply them to engineering design problems
- Build critical thinking and problem solving skills
- Apply the problem-solving design loop to a wide range of engineering problems
- Solve problems through labs and hands-on projects that reinforce skills in the areas of:
 - Motion and Forces
 - Circular Motion
 - Energy

- Waves
- Electromagnetic Radiation
- Electricity and Magnetism
- Physics of the Geosphere

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Curriculum Pacing Chart
Physics

SUGGESTED TIME ALLOTMENT	UNIT NUMBER	CONTENT - UNIT OF STUDY
6 Weeks	I	Force, Motion and Momentum
7 Weeks	II	Circular Motion, Universal Gravitation and Kepler's Laws
5 Weeks	III	Energy
5 Weeks	IV	Wave Properties
6 Weeks	V	Electromagnetic Radiation
4 Weeks	VI	Electricity and Magnetism
3 Weeks	VII	Physics of the Geosphere

RANDOLPH TOWNSHIP SCHOOL DISTRICT

Physics

UNIT I: Force, Motion and Momentum

TRANSFER: Apply Newton’s Laws to analyze the motion of everyday objects such as cars and projectiles (sports balls). Apply the concept of conservation of momentum to predict the motion of interacting bodies (billiards balls).

NGSS	ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
<p>HS-PS2-1: Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.</p> <p>HS-PS2-2: Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.</p> <p>HS-PS2-3: Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</p> <p>HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p>	<p>Newton’s laws describe the motion of objects based upon applied forces.</p>	<ul style="list-style-type: none"> • What causes an object’s motion, both in direction and magnitude?
	<p>Motion can be modeled both graphically and with Newton’s equations of motion.</p>	<ul style="list-style-type: none"> • How can an object’s motion be described both mathematically and graphically?
	<p>Momentum is a conserved quantity.</p>	<ul style="list-style-type: none"> • How is momentum transferred when two bodies interact?
	<p>KNOWLEDGE</p>	<p>SKILLS</p>
	<p>Students will know:</p>	<p>Students will be able to:</p>
	<p>When forces are balanced, no acceleration occurs; thus an object continues to move at a constant velocity or stays at rest.</p> <p>Net force is a vector that is equal to mass times acceleration.</p>	<p>Utilize the Law of Inertia to explain why objects remain in constant motion even while experiencing a force directed toward the ground.</p> <p>Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>Differentiate between weight and mass.</p> <p>Solve motion problems that involve constant forces.</p> <p>Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</p> <p>Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account</p>

	<p>When an object exerts a force on a second object, the second object exerts a force of equal magnitude and opposite direction.</p> <p>Physical quantities can be either a scalar or a vector; Motion is a vector. Two-dimensional motion, including flight, can be broken into the horizontal and vertical vectors.</p> <p>How to solve problems involving elastic and inelastic collisions by using the principles of conservation of momentum.</p> <p>KEY TERMS:</p> <p>Motion, inertia, acceleration, velocity, scalar, vector, net force, conservation, momentum, projectile, projectile motion, mass, weight, weightlessness, frictional force, gravitational force, normal force, contact/field force</p>	<p>for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</p> <p>Distinguish between action and reaction forces and their relative magnitudes.</p> <p>Model motion both graphically and with Newton's equations of motion.</p> <p>Resolve two dimensional vectors into their components and calculate the magnitude and direction of a vector from its components.</p> <p>Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>Calculate the momentum of objects.</p> <p>Predict motions of objects after a given collision.</p>
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ASSESSMENT EVIDENCE: Students will show their learning by:

- Obtain, graph, and interpret data from constant speed lab and inclined plane lab
- Solve multivariable equations that involve position, speed, acceleration, and time

- View video on inertia in space; Develop and conduct a lab to determine the relationship between mass and inertia
- From the crash cart lab, apply the concept of conservation of momentum to predict the motion of interacting bodies
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KEY LEARNING EVENTS AND INSTRUCTION:

- Group/class activity: Object moving with constant motion (graph distance vs time), bathroom scales (Newton's 3rd law)
- Lab: Constant speed (graphing constant speed buggy)
- Lab: Motion down an incline plane
- Lab: Free-fall acceleration
- Lab: Projectile motion (conceptual)
- Lab: Relationship between mass and inertia
- Lab: Impulse Lab (egg in car)
- Lab: Crash Carts (momentum conservation)

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Physics
Unit I: Forces, Motion, and Momentum

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
6 Weeks	Forces, Motion, and Momentum	<p>BOOKS: Conceptual Physics, 3rd Edition, Paul G. Hewitt</p> <p>Interactives: http://www.physicsclassroom.com/Physics-Interactives</p> <p>Youtube videos as visual aids</p> <p>Tutorials: http://www.physicsclassroom.com/class http://www.bozemanscience.com/physics/</p> <p>Practice Questions: http://www.physicsclassroom.com/reviews</p> <p>Worksheets: http://www.physicsclassroom.com/curriculum</p>

RANDOLPH TOWNSHIP SCHOOL DISTRICT

Physics

UNIT II: Circular Motion, Universal Gravitation and Kepler's Laws

TRANSFER: A car rounding a curve at a specified speed does not slide off the road. Model the motion of planets around a star according to the law of Universal Gravitation and Kepler's Laws.

NGSS	ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
<p>HS-PS2-4: Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.</p> <p>HS-ESS1-4: Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.</p>	The force of gravity is a field force exerted by all massive bodies.	<ul style="list-style-type: none"> If all massive bodies exert gravity, how can we describe the gravitational forces between them?
	Kepler's Laws describe the motion of a planetary body.	<ul style="list-style-type: none"> How can we model the orbits of celestial bodies?
	That the tendency of an object to move in a straight line means that to make an object travel in a circular path a force must push or pull inwards towards the center of the circle.	<ul style="list-style-type: none"> If an object tied to a string is being whirled in uniform circular motion around your head, what would its trajectory be if the string broke?
	KNOWLEDGE	SKILLS
	Students will know:	Students will be able to:
	<p>That circular motion requires the application of a constant force directed towards the center of a circle (centripetal force).</p> <p>Gravitational force is an example of a centripetal force.</p> <p>Applying a force to an object perpendicular to the direction of its motion causes it to change direction but not speed.</p>	<p>Solve problems in circular motion using the relationship between tangential speed, distance, and acceleration.</p> <p>Plan and conduct investigations and apply scientific ideas to make sense of Newton's law of gravitation.</p> <p>Describe and predict the gravitational force between objects. Model the gravitational force between two objects.</p> <p>Describe how to simulate gravity.</p> <p>Explain why the United States launches spacecrafts from Florida.</p>

	<p>Weightlessness results when an object is in freefall and does not result from a lack of gravity, the weakest of the fundamental forces.</p> <p>A planet (or any orbiting object) orbits in an elliptical path with varying speeds.</p> <p>KEY TERMS:</p> <p>Gravity, centripetal force, inverse-square law, radius, rotation/revolution, orbit, geosynchronous, eccentricity, inclination, elliptic, Bode's Law, Astronomical Unit</p>	<p>Use mathematical and computational thinking to examine the processes governing the workings of the solar system and universe.</p> <p>Identify on free body diagram the forces acting to pull an object in its circular path. and calculate the magnitude of this force</p> <p>Calculate the weight of an object in various accelerating reference frames.</p> <p>Model the motion of the earth around the sun.</p>
<p>ASSESSMENT EVIDENCE: Students will show their learning by:</p> <ul style="list-style-type: none"> · Obtain, interpret, and graph centripetal force vs centripetal acceleration · Solve equations that involve the acceleration around a curve · Calculate the speed necessary to remain within a roller coaster of a given radius <p>KEY LEARNING EVENTS AND INSTRUCTION:</p> <ul style="list-style-type: none"> · Group/class activity: Object moving in circular motion (record player), modeling our solar system · Lab: Centripetal Force (rubber stopper) · Lab: Engineer plastic spoon catapults 		

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Physics
UNIT II: Circular Motion, Universal Gravitation and Kepler's Laws

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
7 Weeks	Circular Motion and Universal Gravitation	<p>BOOKS: Conceptual Physics, 3rd Edition, Paul G. Hewitt</p> <p>Interactives: http://www.physicsclassroom.com/Physics-Interactives</p> <p>Youtube videos as visual aids</p> <p>Tutorials: http://www.physicsclassroom.com/class http://www.bozemanscience.com/physics/</p> <p>Practice Questions: http://www.physicsclassroom.com/reviews</p> <p>Worksheets: http://www.physicsclassroom.com/curriculum</p>

RANDOLPH TOWNSHIP SCHOOL DISTRICT

**Physics
UNIT III: Energy**

TRANSFER: How does an internal combustion engine transfer work into motion? Design a means for a car to be safer for the occupants during an impact.		
NGSS	ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
<p>HS-PS3-1: Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.</p> <p>HS-PS3-3: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.</p> <p>HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that</p>	Energy, which depends on the motion and interactions of matter, is a conserved property of a system.	<ul style="list-style-type: none"> • What happens to the transfer of mechanical energy when friction is introduced?
	Energy cannot be created nor destroyed, only transferred within or between systems.	<ul style="list-style-type: none"> • How is energy conserved as an object moves between higher and lower altitudes?
	KNOWLEDGE	SKILLS
	Students will know:	Students will be able to:
	The energy in an isolated system is conserved when the energy in the system is converted into and between kinetic, gravitational potential, elastic/spring potential, etc.	<p>Identify the various forms of energy in any given system.</p> <p>Use models to show that in closed systems as one form of energy changes, the total energy of the system remains constant as evidenced by other forms of energy within the system changing by the same amount.</p> <p>Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>Design, build, and refine devices associated with the conversion of energy.</p>

<p>account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real- world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>	<p>Energy is understood as a quantitative property of a system that depends on the motion and interactions of matter, and the total change of energy in any system is equal to the total energy transferred into and out of the system.</p> <p>KEY TERMS:</p> <p>Mechanical energy, Kinetic energy, gravitational potential energy, elastic/spring potential energy, energy conservation, work</p>	<p>Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. Identify losses of energy by the system to the surrounding environment.</p> <p>Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>Use a computer simulation to model the impact of proposed solutions to a complex real- world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>
<p>ASSESSMENT EVIDENCE: Students will show their learning by:</p> <ul style="list-style-type: none"> · Manipulate variable of speed/friction/gravity/mass to construct a simulated roller coaster · Solve real world word problems involving energy conservation in idealized situations · Using sneakers with different rubber soles (or similar activity), determine the energy lost due to friction <p>KEY LEARNING EVENTS AND INSTRUCTION:</p> <ul style="list-style-type: none"> · Group/class activity: Newton’s Cradle · Lab: Wind-up propelled car · Lab: Designing a roller coaster using funderstanding.com simulation · Lab: Ball rolling down ramp has collision with a mass 		

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Physics
UNIT III: Energy

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
5 Weeks	Energy	<p>BOOKS: Conceptual Physics, 3rd Edition, Paul G. Hewitt</p> <p>Interactives: http://www.physicsclassroom.com/Physics-Interactives</p> <p>Youtube videos as visual aids</p> <p>Tutorials: http://www.physicsclassroom.com/class http://www.bozemanscience.com/physics/</p> <p>Practice Questions: http://www.physicsclassroom.com/reviews</p> <p>Worksheets: http://www.physicsclassroom.com/curriculum</p>

RANDOLPH TOWNSHIP SCHOOL DISTRICT

Physics

UNIT IV: Wave Properties

TRANSFER: Create a mechanical wave using a ripple tank and model the motion of a bob in the tank.		
NGSS	ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
<p>HS-PS4-1: Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.</p> <p>HS-PS4-3: Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described by either a wave model or a particle model, and that for some situation one model is more useful than the other.</p>	A wave is a vibration accompanied by a transfer of energy (not matter) that travels through a medium (space or mass).	<ul style="list-style-type: none"> How do you create a wave?
	The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which the wave is passing.	<ul style="list-style-type: none"> How does wavelength, frequency, and the medium affect speed?
	Wave behavior can be modeled as the wave propagates through a medium and when the wave encounters an interface or boundary.	<ul style="list-style-type: none"> How do we perceive waves? Are all waves perceivable?
	KNOWLEDGE	SKILLS
	Students will know:	Students will be able to:
	<p>The relationships between frequency, wavelength, and speed of waves traveling in various media.</p> <p>The difference between an electromagnetic and mechanical wave, how each wave propagates, and label/identify the various parts of each wave (e.g. crest, trough, wavelength, compression, etc.)</p> <p>That certain waves can be represented by sine graphs. From these graphs, wavelength, frequency, amplitude, etc. can be measured.</p> <p>Information can be sent over long distances as a series of wave pulses.</p>	<p>Use data to show that the wave speed for a particular type of wave changes as the medium through which the wave travels, changes.</p> <p>Identify the differences between a mechanical wave and an electromagnetic wave.</p> <p>Describe the color of an object as a result of wave behavior.</p> <p>Model various wave forms.</p> <p>Apply their understanding of how wave properties can be used to transfer information across long</p>

	<p>Waves can add or cancel as they cross, depending on their relative phase, but each wave emerges unaffected by the other wave.</p> <p>KEY TERMS:</p> <p>Wave, wavelength, frequency, wave speed, medium, propagate, longitudinal, transverse, absorption, transmission, reflection, refraction, diffraction, resonance, natural frequency, harmonic, constructive/destructive interference, compression, rarefaction, decibel, Hertz</p>	<p>distances, store information, and investigate nature on many scales.</p> <p>Describe beats and harmonics as a result of wave interference</p> <p>Apply their knowledge of constructive/destructive interference to describe an interaction outcome of two waves.</p>
<p>ASSESSMENT EVIDENCE: Students will show their learning by:</p> <ul style="list-style-type: none"> · Create a mechanical wave using a ripple tank and model the motion of a bob in the tank · Determine the speed of wave using frequency, period, and wavelength · Design and build a simple desktop guitar, using knowledge of waves and harmonics <p>KEY LEARNING EVENTS AND INSTRUCTION:</p> <ul style="list-style-type: none"> · Group/class activity: Slinky demo, standing wave generator, tuning forks (resonance) · Lab: Engineer a guitar on the lab desk · Lab: online wave equation 		

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Physics

UNIT IV: Wave Properties

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
5 Weeks	Wave Properties	<p>BOOKS: Conceptual Physics, 3rd Edition, Paul G. Hewitt</p> <p>Interactives: http://www.physicsclassroom.com/Physics-Interactives</p> <p>Youtube videos as visual aids: https://www.youtube.com/watch?v=ud592YKhePI https://www.youtube.com/watch?v=vvJAgUBF4w</p> <p>Tutorials: http://www.physicsclassroom.com/class http://www.bozemanscience.com/physics/</p> <p>Practice Questions: http://www.physicsclassroom.com/reviews</p> <p>Worksheets: http://www.physicsclassroom.com/curriculum</p> <p>Activities: http://www.earthsciweek.org/classroom-activities/earthquake-playground</p>

RANDOLPH TOWNSHIP SCHOOL DISTRICT

Physics

UNIT V: Electromagnetic Radiation

TRANSFER: Determine some of the uses for various frequency ranges in the EM spectrum; for example, measure the wavelength of a microwave using marshmallows, view ultraviolet waves using your phone camera, determine energy differences between various waves in the EM spectrum (blackbody radiation).

NGSS	ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
<p>HS-PS4-2: Evaluate questions about the advantages of using digital transmission and storage of information.</p> <p>HS-PS4-3: Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described by either a wave model or a particle model, and that for some situation one model is more useful than the other.</p> <p>HS-PS4-4: Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.</p> <p>HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.</p> <p>HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p>	Electromagnetic radiation can be described by multiple models.	<ul style="list-style-type: none"> When is light a wave? When is light a particle?
	The electromagnetic spectrum is a model that demonstrates a range of energies.	<ul style="list-style-type: none"> What are the seven types of electromagnetic radiation, how do they differ, and what are some of their uses?
	Solar cells are human-made devices that capture the sun’s energy and produce electrical energy.	<ul style="list-style-type: none"> How can a solar cell capture and utilize solar energy?
	KNOWLEDGE	SKILLS
	Students will know:	Students will be able to:
	<p>Electromagnetic waves can have varying amounts of energy depending on its wavelength/frequency value from which the wave can be categorized.</p> <p>When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy. Shorter wavelength ER can ionize atoms and cause damage to living cells.</p>	<p>Apply their understanding of wave properties to make sense of how electromagnetic radiation can be used to transfer information across long distances, store information, and be used to investigate nature on many scales.</p> <p>Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants e.g. global warming .</p> <p>Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.</p>

<p>HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.</p>	<p>Photoelectric materials emit electrons when they absorb light of a certain frequency.</p> <p>KEY TERMS:</p> <p>Electromagnetic, radiation, AM/FM, wave function, work function, duality, photoelectric effect, propagate</p>	<p>Evaluate and extrapolate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter e.g. cell phone use.</p> <p>Describe what types of materials are photoelectric and why, and qualitatively describe how the basic physics principles were utilized in absorbing EM and converting it to thermal energy.</p>
<p>ASSESSMENT EVIDENCE: Students will show their learning by:</p> <ul style="list-style-type: none"> · Essay effects of cell phone use on human body cells · Compare and contrast AM and FM waves used to propagate information <p>KEY LEARNING EVENTS AND INSTRUCTION:</p> <ul style="list-style-type: none"> · Lab: Engineer a solar cooker · Lab/Activity: Analyze research about cell phone use 		

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Physics
UNIT V: Electromagnetic Radiation

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
6 Weeks	Electromagnetic Radiation	<p>BOOKS: Conceptual Physics, 3rd Edition, Paul G. Hewitt</p> <p>Interactives: http://www.physicsclassroom.com/Physics-Interactives https://phet.colorado.edu/en/simulation/legacy/photoelectric</p> <p>Youtube videos as visual aids</p> <p>Tutorials: http://www.physicsclassroom.com/class http://www.bozemanscience.com/physics/</p> <p>Practice Questions: http://www.physicsclassroom.com/reviews</p> <p>Worksheets: http://www.physicsclassroom.com/curriculum</p>

RANDOLPH TOWNSHIP SCHOOL DISTRICT

Physics

UNIT VI: Electricity and Magnetism

TRANSFER: Create an electrochemical cell, explaining the source of the moving charges and map and measure the resulting magnetic field lines.		
NGSS	ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
<p>HS-PS2-5: Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.</p> <p>HS-PS3-5: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</p> <p>HS-PS3-2: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).</p>	An electric field exists in space around any static charge or group of static charges. A magnetic field exists in space around any static magnetic dipole.	<ul style="list-style-type: none"> • Can there be a magnetic monopole?
	An electric field is caused by an electric charge or a changing magnetic field. A magnetic field is caused by a magnet or a moving electrically charged object.	<ul style="list-style-type: none"> • What is the origins of an electric or magnetic field?
	Fields existing in space can be used to explain interactions.	<ul style="list-style-type: none"> • How do charged particles apply forces on each other when not in contact?
	KNOWLEDGE	SKILLS
	Students will know:	Students will be able to:
	<p>Forces at a distance can be explained by fields.</p> <p>When two objects interacting through a field change relative positions, the energy stored in the field is changed.</p> <p>Fields are produced either by moving charged particles/objects.</p>	<p>Draw electric and magnetic field lines.</p> <p>Explain why some material are attracted to one another while others are not.</p> <p>Magnets and electric currents cause magnetic fields.</p> <p>Model the effect that changes in relative positions of objects in gravitational, magnetic, or electrostatic fields have upon the energy of the field.</p> <p>Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.</p>

	<p>Interactions between stationary charged point particles are affected by the distance between the charges and the sign and magnitude of the charges.</p> <p>KEY TERMS:</p> <p>Charge, electricity, magnetism, current, field, domains, ferromagnetic, polarity, electrostatic</p>	<p>Apply Coulomb's Law to make predictions about the interaction between electric point charges.</p> <p>Construct an explanation of two charges interacting based on evidence produced by scientific practices.</p> <p>Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</p>
<p>ASSESSMENT EVIDENCE: Students will show their learning by:</p> <ul style="list-style-type: none"> · Draw the results of their electroscopes, explaining charging by induction and conduction · Create a mathematical model of Coulomb's Law using lab data <p>KEY LEARNING EVENTS AND INSTRUCTION:</p> <ul style="list-style-type: none"> · Group/class activity: Vandegraff Generator, electrostatics · Lab: Electroscope (induction/conduction) · Lab: Coulomb's Law (charging a styrofoam pith) · Lab: Explore the relationship between a motor and a generator 		

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Physics
UNIT VI: Electricity and Magnetism

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
4 Weeks	Electricity and Magnetism	<p>BOOKS: Conceptual Physics, 3rd Edition, Paul G. Hewitt</p> <p>Interactives: http://www.physicsclassroom.com/Physics-Interactives</p> <p>Youtube videos as visual aids</p> <p>Tutorials: http://www.physicsclassroom.com/class http://www.bozemanscience.com/physics/</p> <p>Practice Questions: http://www.physicsclassroom.com/reviews</p> <p>Worksheets: http://www.physicsclassroom.com/curriculum</p>

RANDOLPH TOWNSHIP SCHOOL DISTRICT

Physics

UNIT VII: Physics of the Geosphere

TRANSFER: Explore the origin of surface and subsurface resources and account their different properties.		
NGSS	ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
<p>HS-ESS2-1: Develop a model to illustrate how Earth’s internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.</p> <p>HS-ESS2-3: Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection.</p> <p>HS-ESS1-5: Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.</p> <p>HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.</p>	Interactions between systems can result in changes in those systems.	<ul style="list-style-type: none"> • What driving force is responsible for creating continental and oceanic landforms?
	Plate tectonics explains the relative ages based upon position of crustal and oceanic rocks.	<ul style="list-style-type: none"> • Where do we find earth’s youngest and oldest rocks, and why?
	Earth’s systems, being dynamic and interacting, cause feedback effects that increase or decrease the original changes.	<ul style="list-style-type: none"> • How does the accumulation of greenhouse gases exacerbate the rate of climate change?
	KNOWLEDGE	SKILLS
	Students will know:	Students will be able to:
	<p>The tension between internal systems is largely responsible for creating land at Earth's surface.</p> <p>Mantle convection and resulting plate tectonics results from temperature and density gradients.</p>	<p>Explain that the appearance of land features and seafloor features are the result of constructive forces such as volcanism and tectonic features and destructive mechanisms such as weather and erosion.</p> <p>Develop a model to describe the cycling of earth’s materials and the flow of energy that drives this process.</p> <p>Explain how plate tectonics are responsible for continental and ocean floor features.</p> <p>Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection.</p> <p>Explain that plate tectonics is the underlying theory that explains geologic history.</p>

	<p>The age increases as distance from mid-ocean ridges increases.</p> <p>Climate feedback causes changes to other Earth systems.</p> <p>KEY TERMS:</p> <p>Plate tectonics, feedback, system, convection, mantle, climate, atmosphere, subduction, volcanism, rift, syncline, anticline, crust, density, gradient, erosion, turbidity</p>	<p>Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.</p> <p>Explain how an increase in greenhouse gases causes a rise in global temperatures and ramifications of increased temperatures.</p> <p>Explain that the foundation for Earth’s climate system is EM radiation from the sun as well its reflection and absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and energy’s re-radiation into space.</p> <p>Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.</p>
<p>ASSESSMENT EVIDENCE: Students will show their learning by:</p> <ul style="list-style-type: none"> · Creation of an accurate topographic map · Model tectonic movement through collision of simulated tectonic plates <p>KEY LEARNING EVENTS AND INSTRUCTION:</p> <ul style="list-style-type: none"> · Group/class activity: Make a contour map. · Lab: Analyzing floods (http://www.nextgenscience.org/sites/default/files/HS-ESS_Analyzing_Floods-version2.pdf) 		

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Physics

UNIT VII: Physics of the Geosphere

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
3 Weeks	Physics of the Geosphere	<p>BOOKS: Conceptual Physics, 3rd Edition, Paul G. Hewitt</p> <p>Interactives: http://www.physicsclassroom.com/Physics-Interactives</p> <p>Youtube videos as visual aids</p> <p>Tutorials: http://www.physicsclassroom.com/class http://www.bozemanscience.com/physics/</p> <p>Practice Questions: http://www.physicsclassroom.com/reviews</p> <p>Worksheets: http://www.physicsclassroom.com/curriculum</p> <p>Tasks: www.nextgenscience.org/classroom-sample-assessment-tasks Center for innovation in engineering and science education</p>

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APPENDIX A

Resources:

Textbook:

Conceptual Physics; Hewitt, Paul G. 3rd Edition

ISBN-13: 9780201466973

Copyright: 1997

Book of additional word problems:

Problem-Solving Exercises in Physics

Author: Hickman, Jennifer Bond

ISBN: 0-201-24758-5

Copyright 1991 Addison-Wesley Publishing Company, Inc

Technology

Various Vernier software and sensors

Web Sites

Virtual Labs: www.Phet.colorado.edu

Online physics tutorial: www.physicsclassroom.com

NGSS Aligned activities:

www.teacherstryscience.org/ngsslp

<https://phet.colorado.edu/services/download-servlet?filename=%2Factivities%2F4127%2FHSS+NGSS+Alignment+10-7.docx>

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APPENDIX B

ASSESSMENT:

- **Quizzes**
- **Tests**
- **Individual Projects**
- **Group Projects**
- **Homework**
- **Labs**
- **Benchmarks**

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APPENDIX C

Opportunities exist for interdisciplinary units with courses such as Algebra II, Calculus, Trigonometry and Environmental Science.

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APPENDIX D

It is assumed that the student has successfully completed Algebra I, and four semesters of a Science.

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APPENDIX E

Lesson plans to follow as curriculum is implemented.