Paulsboro Schools

Curriculum

<Physics>

Grade < 11-12 >

<2011 - 2012>

*** For adoption by all regular education programs**
Board Approved: <Month Year>
as specified and for adoption or adaptation by
all Special Education Programs in accordance
with Board of Education Policy.

PAULSBORO SCHOOL DISTRICT

Curriculum writing team members: Nelson Hall

Paulsboro Schools Mission Statement

The mission of the Paulsboro School District is to provide each student educational opportunities to assist in attaining their full potential in a democratic society.

Our instructional programs will take place in a responsive, community based school system that fosters respect among all people.

Our expectation is that all students will achieve the New Jersey Core Curriculum Content Standards (NJCCCS) at every grade level.

INTRODUCTION, PHILOSOPHY OF EDUCATION, AND EDUCATIONAL GOALS

Introduction/Philosophy: The philosophy of the Paulsboro School District Language Arts Literacy Program is to provide students with a multitude of educational opportunities and 21st century skills necessary for the lifelong learning. The educational program takes into account the physical, social, and emotional needs of every student. We recognize that students come to school with prior knowledge and learn best when they can communicate views effectively through reading, writing, listening, thinking , and viewing the world in which we live. Emphasis on language is placed on authentic, problem/ project based situations that provide opportunities for students to interact with new understandings which they link to prior knowledge. Through open-ended activities, students engage in interdisciplinary studies based where they are and take their learning as far as possible. Because of the global and ever changing nature of our society, the Language Arts Literacy Program will engage students with the experiences necessary to develop the threshold skills of critical thinking, strategizing, communicating, and acting democratically in the world.

Educational Goals (taken from NJCCCS)

1. Communicate scientific principals in clear, concise, organized language that varies in content, format, and form for different audiences and purposes
2. Comprehend, understand, analyze, evaluate, critique, and respond to messages from various formats.
3. Investigate, research, and synthesize information from various media sources.>

Physics
Scope and Sequence Map

<table>
<tr><th colspan="2">Quarter 1</th></tr>
<tr><td>Big Idea:
I. One Dimensional Motion
a. <u>Patterns</u> – Distinguish between distance and displacement and be able to calculate them for an object. Distinguish between speed and velocity and be able to calculate them for an object. Apply the kinematic equations to analyze the motion of an object with constant acceleration. Explain the relationship between a changing velocity and acceleration. Apply the acceleration due to gravity in the given system to analyze the motion of a free-falling object. Analyze unit prefixes to describe large or small numbers and be able to convert to SI units.
b. <u>Models</u> – Apply diagrams, graphs, and mathematical models to analyze the motion of an object. Design and interpret graphs of position versus time and velocity versus time.
c. <u>Society</u> - Describe the social, historical, political, philosophical, and economic impacts of being able to analyze the motion of an object.</td><td>Big Idea:
II. Projectile Motion
a. <u>Patterns</u> – Describe the horizontal and vertical motion of a projectile in the absence of air resistance. Apply the kinematic equations to analyze the motion of a projectile. Explain how the acceleration due to gravity, air resistance, launch angle, and launch speed will affect the motion of a projectile.
b. <u>Models</u> –Apply diagrams, tables, and mathematical models to analyze the motion of a projectile.
c. <u>Society</u> - Describe the social, historical, political, philosophical, and economic impacts of being able to analyze the motion of a projectile.</td></tr>
<tr><td></td><td></td></tr>
<tr><th colspan="2">Quarter 2</th></tr>
<tr><td>Big Idea:
III. Vector Addition
a. <u>Patterns</u> – Distinguish between vector and scalar quantities. Apply trigonometric functions and the Pythagorean Theorem to resolve and add vectors.
b. <u>Models</u> – Draw vector diagrams to add and resolve vectors.
c. <u>Society</u> – Describe the social, historical, political, philosophical, and economic impacts of adding and resolving vectors.</td><td>Big Idea:
IV. Newton's Laws of Motion
a. <u>Patterns</u> – Describe the relationship between adding forces and adding vectors. Describe Newton's Laws of motion and use them to analyze the motion of an object. Distinguish between weight and mass and compare each on Earth to that on other massive bodies. Compare the coefficients of friction for various surfaces. Explain the relationship of the coefficient of friction and normal force to the force of friction. Analyze bodies on inclined planes and forces applied in two dimensions.
b. <u>Models</u> –Apply free-body diagrams to analyze the forces acting on a body and its motion.
c. <u>Society</u> - Describe the social, historical, political, philosophical, and economic impacts of Newton's Laws.</td></tr>
</table>

Big Idea: V. Circular Motion a. Patterns – Explain how the apparent existence of a centrifugal force can be explained as inertia resisting the centripetal force. Calculate the centripetal acceleration and centripetal force for a rotating object. Explain the relationship between the mass of two bodies, the distance between them, and the gravitational force exerted between them and relate this to Newton's Universal Law of Gravitation. Calculate the unknown in a problem using the force that causes circular motion. Identify the force which causes circular motion such as friction, normal force, tension, or gravitational force. b. Models – Apply vector diagrams to analyze the motion of various rotating objects. c. Society - Describe the social, historical, political, philosophical, and economic impacts of analyzing rotating objects.	

Quarter 3

Big Idea: VI. Work and Energy Conservation a. Patterns – Calculate the net work done on an object. Distinguish between kinetic energy, gravitational potential energy, and elastic potential energy. Describe the relationship between work and energy and relate this to the work-energy theorem. Understand that the total mechanical energy of the system is conserved. Apply the work-energy theorem to analyze the motion of various bodies. Describe the energy transformations that occur for various moving bodies. Identify non-mechanical and mechanical energy transformations for a given system. b. Models – Apply diagrams to analyze the work done on various bodies and the energy transformations that occur. c. Society - Describe the social, historical, political, philosophical, and economic impacts of analyzing work and energy.	**Big Idea:** VII. Momentum a. Patterns – Relate force and time (impulse) to a change in momentum. Distinguish between elastic, inelastic, and perfectly inelastic collisions. Apply conservation of momentum to analyze the motion of two bodies in a collision. Apply conservation of energy to analyze the motion of two bodies in an elastic collision. Determine the energy lost during an inelastic collision. b. Models – Draw diagrams to analyze the momentum of two bodies before and after a collision. c. Society - Describe the social, historical, political, philosophical, and economic impacts of analyzing momentum.

Quarter 4

Big Idea: VIII. Electric Forces and Fields a. Patterns – Relate the structure of an atom to conductors and insulators. Distinguish between charging by grounding, contact, induction, and polarization for conductors and insulators. Apply Coulomb's Law to determine the net electric force acting on a charge with forces acting in two dimensions. Calculate the net electric field strength at the location of a point charge with electric fields in two dimensions. b. Models – Draw charge diagrams to analyze the movement of electrons within a system. Draw free-body diagrams to analyze the net electric force and net electric field acting on a charge. Analyze electric field diagrams. c. Society – Describe the social, historical, political, philosophical, and economic impacts of analyzing static electricity.	**Big Idea:** IX. Electric Energy, Current, and Resistance a. Patterns – Relate voltage to electric potential energy and electric charge and perform calculations using this relationship. Apply the relationship between current, charge, and time. Apply Ohm's Law to analyze the resistance of a material and the current flowing through it. Distinguish between direct and alternating current. Relate electrical power to mechanical power. Explain how various factors affect the resistance of a material. Calculate the cost of running various loads. b. Society - Describe the social, historical, political, philosophical, and economic impacts of current electricity.
Big Idea: X. Circuits a. Patterns – Explain how current flows through a series circuit versus and parallel circuit. Explain how voltage is divided between loads connected in series and parallel. Find the equivalent resistance of resistors connected in series and resistors connected in parallel. Apply Ohm's Law to analyze the current and voltage at various points in a series and parallel circuit. b. Society – Describe the social, historical, political, philosophical, and economic impacts of building and analyzing electric circuits. c. Models – Interpret and construct schematic diagrams.	

Curriculum Management System – Big Idea 1

<table>
<tr><td>Subject/ Grade level
Physics 11-12</td><td colspan="2">Suggested days of instruction: 21</td></tr>
<tr><td rowspan="5">Quarter 1
Objective/ Cluster Concept/ Cumulative Progress Indicators

The student will be able to:
1.1. Distinguish between distance and displacement and be able to calculate them for an object. (5.2.12.E.1, 5.1.12.D.2)

1.2. Distinguish between speed and velocity and be able to calculate them for an object. (5.2.12.E.1, 5.1.12.D.2)

1.3. Apply the kinematic equations to analyze the motion of an object with constant acceleration. (5.2.12.E.1)

1.4. Explain the relationship between a changing velocity and acceleration. (5.2.12.E.1, 5.1.12.D.2)

1.5. Use the acceleration due to gravity in the given system to analyze the motion of a free-falling object. (5.2.12.E.1, 5.1.12.A.1, CCSSI.S.8)</td><td colspan="2">Big Idea: Inquiry</td></tr>
<tr><td colspan="2">Topic: One Dimensional Motion</td></tr>
<tr><td colspan="2">Overarching Goals:
(1) Apply mathematics to the physical world.
(2) Comprehend, understand, analyze, evaluate, critique, solve, and respond to a variety of real-life, meaningful problems.
(3) Investigate, research, and synthesize the societal impact of the study of physics.</td></tr>
<tr><td colspan="2">Goal 1: The student will be able to analyze the motion of objects moving horizontally or vertically with a constant velocity or constant acceleration.</td></tr>
<tr><td>Essential Questions:
• How can kinematic data be modeled and analyzed and what information can this reveal?
• How do gravity, horizontal kinematic patterns, and vertical kinematic patterns compare on Earth with that on other massive bodies?
• What are the social and economic impacts of analyzing kinematic patterns?

Enduring Understanding:

A small number of known values and a basic understanding of the patterns involved in motion can reveal a wide variety of kinematic information.</td><td>NOTE: The assessment models provided in this document are suggestions for the teacher. If the teacher chooses to develop his/her own model, it must be of equal or better quality and at the same or higher cognitive levels (as noted in parentheses). Depending upon the needs of the class, the assessment questions may be answered in the form of essays, quizzes, mobiles, PowerPoint, oral reports, booklets, or other formats of measurement used by the teacher.</td></tr>
</table>

1.6. Use unit prefixes to describe large or small numbers and be able to convert to SI units. (CCSSI.S.4) 1.7. Describe the social, historical, political, philosophical, and economic impacts of being able to analyze the motion of an object. (5.1.12.C.1, 5.1.12.C.2, 5.1.12.C.3) 1.8. Use diagrams, graphs, and mathematical models to analyze the motion of an object. (5.1.12.D.2, 5.1.12.B.1) 1.9. Design and interpret graphs of position versus time and velocity versus time. (5.1.12.A.2)	Measurement involves uncertainty; therefore, data collection is incomplete without data analysis. Kinematic motion may be represented, analyzed and interpreted graphically, by use of tables, and by applying mathematics. The analysis and study of kinematic patterns has social, historical, political, philosophical, and economic outcomes. Gravity influences all airborne objects equally regardless of mass or shape.	**Learning Activities:** **Learning Activity #1** Tell students to imagine they work for a toy company. It is their job to determine if a toy car moves at a constant or changing speed. Tell students to design and perform an experiment then analyze the data to determine this. They may use meter sticks, stopwatches, masking tape, and sandbags to take measurements that will be shown in a data table. Students should analyze and represent data using the following methods: verbal model, pictorial model, graphical model, mathematical model. Draw a conclusion from the data to determine if the car moved at a constant or changing speed. Tell them to present their findings to their boss. *(Analysis, Evaluation, Synthesis)* **Learning Activity #2** Tell students to imagine they are an athlete in training. They will perform ladder sprints and analyze their motion to determine if they moved at a constant or changing speed during each interval and how fast they moved during each interval. Their results will be presented to their peers to compare themselves to their "competition." They will use a Pasco motion sensor to collect data. *(Analysis, Evaluation, Application)*

		Assessment Model #1: Tell students to imagine they are Galileo conducting an experiment to examine the rate at which objects fall. Aristotle claims that all objects fall at a constant speed but they want to either verify this or prove him incorrect. Instead of dropping an object they will roll it down an incline; it will be easier to analyze. They will create a publication (formal lab report) that will change the way future scientists view falling objects. If they find that the object does not move at a constant speed then they must also determine the rate at which the object falls. 2 graphs must be included in their report. *(Analysis, Synthesis, Evaluation)* **Learning Activity #3:** Tell students to imagine they are boxers. They must have excellent reaction time and hand-eye coordination. Their coach wants to measure and improve their reaction time and compare it to that of their opponents. Each group must devise an experiment to measure reaction time using only a meter stick. Each group member will perform 3 trials and take the average value. They should calculate their reaction time and then compare it to that of their peers (opponents).Next, they are basketball players trying to improve their hang time. Find a clearing on a wall in the classroom, jump, place a piece of masking tape on the wall at the highest point, then come back to the ground. They should perform 3 trials, measuring their displacement. They can use this value to calculate their hang time. They will compare their hang times to that of their peers. *(Application, Analysis, Evaluation)*

		Assessment Model #2: Formative assessments will be used to assess transfer of knowledge. A summative assessment will be given at the conclusion of this unit. **Additional Resources:** http://phet.colorado.edu/en/simulation/moving-man http://physicsworld.com/cws/article/print/16806 Datastudio E-Z launch program with motion sensor. Zitzewitz, Paul W. (1999). *Physics – Principles and Problems.* New York: Glencoe Kennedy, Daniel. (2010). Calculus- Graphical, Numerical, Algebraic. Boston: Prentice Hall Larson, Ron. (2009). Calculus of a Single Variable. New York: Houghton Mifflin Company http://www.design-simulation.com/ip/index.php

Curriculum Management System - Big Idea 2

Subject/ Grade level
Physics (11-12)

Suggested days of instruction: 21

Quarter 1
Objective/ Cluster Concept/ Cumulative Progress Indicators

The student will be able to:

2.1. Describe the horizontal and vertical motion of a projectile in the absence of air resistance. (5.2.12.E.1, 5.1.12.B.2)

2.2. Use the kinematic equations to analyze the motion of a projectile. (5.2.12.E.1)

2.3. Explain how the acceleration due to gravity, air resistance, launch angle, and launch speed will affect the motion of a projectile. (5.1.12.B.1, 5.1.12.D.1)

2.4. Use diagrams, tables, and mathematical models to analyze the motion of a projectile. (5.1.12.D.2)

Big Idea 2 Evaluate

Topic: Two dimensional Motion

Overarching Goals:

(1) Apply mathematics to the physical world.
(2) Comprehend, understand, analyze, evaluate, critique, solve, and respond to a variety of real-life, meaningful problems.
(3) Investigate, research, and synthesize the societal impact of the study of physics.

Goal 2: The student will be able to analyze the motion of projectiles.

Essential Questions:

- What impacts have analyzing projectiles had on society?
- What affects the path of a projectile?
- What are the relationships between one dimension kinematic motion and two dimension kinematic motion?

Enduring Understanding:

The kinematic patterns for one dimensional motion on the ground and one dimensional motion in the air can be combined to explain two dimensional motion in the air.

The horizontal and vertical components of two dimensional motion act independently.

The understanding that two dimensional motion has social, historical, political, philosophical and economic outcomes.

Learning Activities:

Tell students to imagine they are a scientist who wants to understand the path of a projectile moving in a vacuum. They will observe this path using the Interactive Physics program then use the print out of the strobe image to analyze it. They need to write an analysis and conclusion to that will be presented to other scientists in the community. It must correctly explain how a projectile moves in the vertical direction and horizontal direction. Before they are finished they must run the program again to test their ideas.

(Knowledge, Comprehension, Analysis)

2.5. Describe the social, historical, political, philosophical, and economic impacts of being able to analyze the motion of a projectile. (5.1.12.C.1, 5.1.12.C.2, 5.1.12.C.3)		**Assessment Models:** Tell students to imagine they are competing in a competition against their classmates. Imagine they are releasing a rock in a giant slingshot off the side of a cliff. There is a tiny bull's eye at the bottom of the cliff which they must hit. Students should work in groups of four to predict the landing location of a launched projectile ball. They will calculate the initial velocity of the ball, then change the angle of the launcher and predict the landing location. The predictions will be tested using carbon paper. They will be graded on their calculations, predictions, and analysis. *(Application, Analysis, Evaluation)* (Note: Optional) In addition to the above or in place of: Tell students they are a computer scientist who has been asked by a client to create an Excel spreadsheet that will calculate the landing position of the ball. It must work for a launch at any height and angle. The only inputs from the user for the first part will be the angle, height, and horizontal displacement so the program will calculate the initial speed. The inputs from the second part will be the new angle and height. They must test their program with 3 different launches. *(Application, Synthesis)* **Assessment Model #2:** Formative assessments will be used to assess transfer of knowledge. A summative assessment will be given at the conclusion of this unit.

Curriculum Management System – Big Idea 3

Subject/ Grade level **Physics (11-12)**	**Suggested days of instruction: 10**	
Quarter 2 **Objective/ Cluster Concept/ Cumulative Progress Indicators Taken from CPI's in NJCCCS standards** **The student will be able to:** 3.1. Distinguish between vector and scalar quantities. (5.2.12.E.1, CCSSI.S.4) 3.2. Apply trigonometric functions and the Pythagorean Theorem to resolve and add vectors. (5.2.12.E.1) 3.3. Draw vector diagrams to add and resolve vectors. (5.1.12.D.2) 3.4. Describe the social, historical, political, philosophical, and economic impacts of adding and resolving vectors. (5.1.12.C.1, 5.1.12.C.2,5.1.12.C3)	**Big Idea: Analyze** **Topic: Vector Addition** **Overarching Goals:** **(1) Apply mathematics to the physical world.** **(2) Comprehend, understand, analyze, evaluate, critique, solve, and respond to a variety of real-life, meaningful problems.** **(3) Investigate, research, and synthesize the societal impact of the study of physics.** **Goal 3: The student will be able to analyze a problem involving vector addition.**	
	Essential Questions: • How can vector models be used to analyze the physical world? • How can mathematics be applied to vector quantities and why is it necessary to do so? **Enduring Understandings:** Vector models are abstract representations of physical quantities. Vector models can be used to analyze and predict a wide variety of physical outcomes. The application of mathematics to vector models of physical quantities is necessary to understand naturally occurring patterns that exist in the physics world.	**Learning Activities:** Tell students to imagine they are completing a word puzzle in a treasure hunt fashion. They will be given a set of vectors to resolve. Each resolved vector will lead they to a new chair and therefore a new letter and number. Upon collecting all data, the letters should spell the name of a scientist and a number associated with him/her. Use the internet to find out what that scientist is known for and how that number is related to them. Each group will report back to their classmates to share their research findings about their scientist. *(Application, Evaluation)*

Assessment Models:

A long formative assessment or short summative assessment will be given at the conclusion of this section.

Additional Resources:

http://www.surendranath.org/Applets/Math/VectorAddition/VectorAdditionApplet.html

http://phet.colorado.edu/en/simulation/moving-man

http://physicsworld.com/cws/article/print/16806

Datastudio E-Z launch program with motion sensor.

Zitzewitz, Paul W. (1999). *Physics – Principles and Problems.* New York: Glencoe

Kennedy, Daniel. (2010). Calculus- Graphical, Numerical, Algebraic. Boston: Prentice Hall

Larson, Ron. (2009). Calculus of a Single Variable. New York: Houghton Mifflin Company

http://www.design-simulation.com/ip/index.php

Curriculum Management System – Big Idea 4

<table>
<tr><td>Subject/ Grade level
Physics (11-12)</td><td colspan="2">Suggested days of instruction 20</td></tr>
<tr><td rowspan="5">Quarter 2
Objective/ Cluster Concept/ Cumulative Progress Indicators Taken from CPI's in NJCCCS standards

The student will be able to:
4.1. Describe the relationship between adding forces and adding vectors. (5.2.12.E.3)

4.2. Describe Newton's Laws of motion and use them to analyze the motion of an object. (5.2.12.E.3, 5.2.12.E.4, CCSSI.S.9, CCSSI.S.3)

4.3. Distinguish between weight and mass and compare each on Earth to that on other massive bodies. (5.2.12.E.4)

4.4. Compare the coefficients of friction for various surfaces. (5.1.12.B.1, CCSSI.S.2)</td><td colspan="2">Big Idea: Evaluate</td></tr>
<tr><td colspan="2">Topic: Newton's Laws of Motion</td></tr>
<tr><td colspan="2">Overarching Goals:
(1) Apply mathematics to the physical world.
(2) Comprehend, understand, analyze, evaluate, critique, solve, and respond to a variety of real-life, meaningful problems.
(3) Investigate, research, and synthesize the societal impact of the study of physics.</td></tr>
<tr><td colspan="2">Goal 4: The students will be able to apply Newton's Laws of motion of various objects and the forces acting on them.</td></tr>
<tr><td>Essential Questions:

• How can the acceleration of an object be affected?

• Why is it important to know what is causing a change in motion of an object?

• How did Newton's Laws of motion affect society and the scientific community?

Enduring Understandings:
An unbalanced net force causes a change in motion.

Kinematic determinations may be made by understanding dynamics.

A force cannot be applied (action) without an equal and opposite force (reaction) being felt.</td><td>Learning Activity:

Tell students to imagine they are a scientist who wants to know the relationship between force, mass, and acceleration. They will use the PASCO force detectors, dynamics car, track, and masses to determine this relationship. The force will be applied by the weight of the hanging masses. Use collected data to write a mathematical model that describes the relationship between force, mass, and acceleration.
(Analysis, Synthesis)

Assessment Model:
Tell students to imagine they work for a shoe company and have been given the task of testing the coefficient of friction for various materials that</td></tr>
</table>

4.5. Explain the relationship of the coefficient of friction and normal force to the force of friction. (5.1.12.B.1, 5.1.12.B.2, 5.1.12.B.3) 4.6. Analyze bodies on inclined planes and forces applied in two dimensions. (5.2.12.E.4) 4.7. Use free-body diagrams to analyze the forces acting on a body and its motion. (5.1.12.A.2, 5.1.12.D.2, 5.2.12.E.3) 4.8. Describe the social, historical, political, philosophical, and economic impacts of Newton's Laws on society. (5.1.12.C.1, 5.1.12.C.2, 5.1.12.C.3)	The understanding of the causes of motion on Earth and the ability to quantify forces, including weight has social, historical, political, philosophical and economic outcomes. It is important to know how and under what circumstances scientific ideas were originally developed to understand present day understandings of the physical world.	may be used as soles. Design an experiment to collect data then present their findings to their boss. They must argue whether or not they believe these materials would be appropriate soles for future shoes. (Suggested presentation of data and graphs is a formal lab report.) *(Analysis, Evaluation, Synthesis, Application)* **Learning Activity #2:** Tell students to imagine they are a scientist trying to determine the maximum coefficient of static friction between a penny and book cover. Devise an experiment to determine this coefficient. Upon completion they should compare their value to that determined by their peers. *(Application, Synthesis)* **Assessment Model #2:** Formative assessments will be used to assess transfer of knowledge. A summative assessment will be given at the conclusion of this unit. **Additional Resources:** Datastudio E-Z launch program with motion sensor. Zitzewitz, Paul W. (1999). *Physics – Principles and Problems.* New York: Glencoe Kennedy, Daniel. (2010). Calculus- Graphical, Numerical, Algebraic. Boston: Prentice Hall Larson, Ron. (2009). Calculus of a Single Variable. New York: Houghton Mifflin Company http://www.design-simulation.com/ip/index.php

Curriculum Management System Big Idea 5

Subject/ Grade level Physics (11-12)	Suggested days of instruction:20	
Quarter 2 **Objective/ Cluster Concept/ Cumulative Progress Indicators Taken from CPI's in NJCCCS standards**	**Big Idea: Analyze**	
	Topic: Circular Motion	
	Overarching Goals: **(1) Apply mathematics to the physical world.** **(2) Comprehend, understand, analyze, evaluate, critique, solve, and respond to a variety of real-life, meaningful problems.** **(3) Investigate, research, and synthesize the societal impact of the study of physics.**	
The student will be able to: 5.1. Explain how the apparent existence of a centrifugal force can be explained as inertia resisting the centripetal force. (5.2.12.E.3) 5.2. Calculate the centripetal acceleration and centripetal force for a rotating object. (5.2.12.E.2, 5.2.12.E.4) 5.3. Explain the relationship between the mass of two bodies, the distance between them, and the gravitational force exerted between them and relate this to Newton's Universal Law of Gravitation. (5.4.8.A.3) 5.4. Calculate the unknown in a problem using the force that causes circular motion.	**Goal 5: The student will be able to analyze the motion of rotating and revolving objects.**	
	Essential Questions: • How can kinematics and Newton's Laws be used to predict the path of objects in uniform circular motion? • What forces could act as a centripetal force and in what real-life scenarios could this occur? **Enduring Understandings:** Newton's work on universal gravitation gives an explanation for motion throughout the universe. A centripetal force can be caused by many types of forces but is always directed toward the center of the circular path. Kinematics and dynamics (Newton's Laws of motion) can be applied to objects with uniform circular motion to analyze and predict their path.	**Learning Activities:** Tell students to imagine they are working on the design for a new amusement park ride that rotates. Students need to know the speed of the rider on the end to make sure it will be safe. Tell students to use a constant speed car to represent the rider and to devise a simple method of calculating the speed of the car. Each group may use string, the car, a meter stick, and masking tape. *(Synthesis)* **Assessment Model:** Tell students to imagine they are an astronaut launching a rocket to the moon. They want to use the least amount of fuel as possible so they decide to turn off the engine at some point during the journey. Create an excel spreadsheet that will determine the distance from Earth's surface that the engine will be turned off. Include two force vs. distance graphs: one that shows the entire journey and another that shows a close up of the point when the engine is turned off. *(Application, Synthesis, Analysis)*

(5.1.12.D.1, 5.2.12.E.4) 5.5. Identify the force which causes circular motion such as friction, normal force, tension, or gravitational force. (5.1.12.D.2) 5.6. Use vector diagrams to analyze the motion of various rotating objects. (5.1.12.D.2) 5.7. Describe the social, historical, political, philosophical, and economic impacts of analyzing rotating objects. (5.2.12.E.2, 5.1.12.C.1, 5.1.12.C.2)		**Learning Activity #2:** Tell students to imagine they are a scientist using a computer program (Interactive Physics) to analyze an object with uniform circular motion. They must come up with mathematical models that describe the motion they observe then use the mathematical models to predict motion. Tell them to use the worksheet to guide them and record their answers on the worksheet. Upon completion compare their mathematical models to their peers to see if there is agreement. *(Analysis, Synthesis, Evaluation)* **Assessment Model #2:** Formative assessments will be used to assess transfer of knowledge. A summative assessment will be given at the conclusion of this unit. **Additional Resources:** http://www.phy.ntnu.edu.tw/ntnujava/index.php?topic=398 http://www.smaphysics.ca/phys40s/field40s/newtmtn.html Zitzewitz, Paul W. (1999). *Physics – Principles and Problems.* New York: Glencoe Kennedy, Daniel. (2010). Calculus- Graphical, Numerical, Algebraic. Boston: Prentice Hall Larson, Ron. (2009). Calculus of a Single Variable. New York: Houghton Mifflin Company http://www.design-simulation.com/ip/index.php

Curriculum Management System Big Idea 6

Subject/ Grade level **Physics (11-12)**	**Suggested days of instruction: 20**

Quarter 3
Objective/ Cluster Concept/ Cumulative Progress Indicators Taken from CPI's in NJCCCS standards

The student will be able to:

6.1. Calculate the net work done on an object. (5.2.12.E.3)

6.2. Distinguish between kinetic energy, gravitational potential energy, and elastic potential energy. (5.2.12.D.1)

6.3. Describe the relationship between work and energy and relate this to the work-energy theorem. (5.2.8.D.1)

6.4. Understand that the total mechanical energy of the system is conserved. (5.2.8.D.1, CCSSI.S.7)

6.5. Apply the work-energy theorem to analyze the motion of various bodies. (5.2.12.D.1, 5.2.12.E.1)

Big Idea 6

Topic: Work and Energy Conservation

Overarching Goals:

(1) Apply mathematics to the physical world.
(2) Comprehend, understand, analyze, evaluate, critique, solve, and respond to a variety of real-life, meaningful problems.
(3) Investigate, research, and synthesize the societal impact of the study of physics.

Goal 6: The students will be able to analyze the motion of an object using energy conservation and the work-energy theorem.

Essential Questions:

- How can the work-energy theorem be used to analyze and predict the motion of an object?
- Why would they use the work-energy theorem to analyze the motion of an object instead of Newton's Laws and kinematic equations?
- What are the social and economic impacts of understanding work, power, and energy conservation?

Enduring Understanding:

Energy can take many forms and can transform from one form to another, but the total energy is always conserved.

Doing work requires energy while an object with energy can do work.

Learning Activities:

Tell students to imagine they are competing in a competition to generate the greatest power while carrying books up a flight of stairs. To determine their power, take measurements to determine the amount of work they will do and then time their ascent. They will use these values to calculate the power generated. They should determine their power in Watts and horsepower to compare themselves to a motor. They can then compare their power with their peers to see who wins the competition.
(Application, Evaluation)

Learning Activity #2:
Tell students to imagine they are Tarzan and they want to swing on a vine in the jungle to get across a river. They must determine the strength of the vine to make sure it is strong enough to hold them. They will use PASCO force meters and equipment, laptops, string, bobs, and meter sticks. Use the bob and string to represent

6.6. Describe the energy transformations that occur for various moving bodies. (5.2.8.D.1) 6.7. Identify non-mechanical and mechanical energy transformations for a given system. (5.2.8.D.1) 6.8. Use diagrams to analyze the work done on various bodies and the energy transformations that occur. (5.1.12.D.2) 6.9. Describe the social, historical, political, philosophical, and economic impacts of analyzing work and energy. (5.1.12.C.1, 5.1.12.C.2, 5.1.12.C.3)	The quantification of work, power, and energy has social, historical, political, philosophical and economic outcomes.	Tarzan on the vine. They should raise the bob to an initial height of their choice, calculate the maximum force (tension) that acts on the rope during the swing, and then test their calculation using the force meter. They will be graded on accuracy, calculations, and conclusion. (Optional Activity) *(Application, Analysis)* **Assessment Models:** Tell students to imagine they work for a toy company that is trying to create their version of a Slinky. It is their job to determine the spring constant of a Slinky and compare it to the spring constant of the company's version. Tell them to devise an experiment that will measure the spring constant for a weak spring and a strong spring. To verify their results they will use the measured spring constants to measure the mass of an unknown object. They should then measure the actual mass using a scale and perform a percent error calculation for each spring. Their findings are to be reported to their boss in a formal lab report. *(Analysis, Synthesis, Evaluation)* **Learning Activity #3:** Tell students to imagine they are an engineer who has been hired to design the newest roller coaster at Six Flags Great Adventure. They are also in charge of making sure that this ride is effective, safe, and a thrill for riders. Tell students to draw a picture of the roller coaster and label the heights of each hill and loop. It must include 3 hills, 1 loop, and 1 banked curve. They should calculate the energy and speed of the riders at the top and bottom of each hill and loop to ensure safety. Ensure that the g-force does not exceed 4g's on any banked curves or

		loops. They must determine a safe stopping distance and force (less than 7 g's) for riders as well. *(Analysis, Synthesis)* **Other Assessment Models:** Formative assessments will be used to assess transfer of knowledge. A summative assessment will be given at the conclusion of this unit. **Additional resources:** http://www.4physics.com/phy_demo/HookesLaw/HookesLaw.html http://phet.colorado.edu/en/simulation/energy-skate-park Zitzewitz, Paul W. (1999). *Physics – Principles and Problems.* New York: Glencoe Kennedy, Daniel. (2010). Calculus- Graphical, Numerical, Algebraic. Boston: Prentice Hall Larson, Ron. (2009). Calculus of a Single Variable. New York: Houghton Mifflin Company http://www.design-simulation.com/ip/index.php

Curriculum Management System Big Idea 7

<table>
<tr><td>Subject/ Grade level
Physics (11-12)</td><td colspan="2">Suggested days of instruction: 20</td></tr>
<tr><td rowspan="5">Quarter 3
Objective/ Cluster Concept/ Cumulative Progress Indicators Taken from CPI's in NJCCCS standards

The student will be able to:
7.1. Relate force and time (impulse) to a change in momentum. (5.2.12.D.4, 5.2.12.E.3, 5.2.12.E.4)

7.2. Distinguish between elastic, inelastic, and perfectly inelastic collisions. (5.2.12.D.4, 5.1.12.D.1, CCSSI.S.5)

7.3. Apply conservation of momentum to analyze the motion of two bodies in a collision. (5.2.12.D.4, 5.1.12.D.1)

7.4. Apply conservation of energy to analyze the motion of two bodies in an elastic collision. (5.2.12.D.4)

7.5. Determine the energy lost during an inelastic collision. (5.2.12.D.4)</td><td colspan="2">Big Idea 7</td></tr>
<tr><td colspan="2">Topic: Momentum</td></tr>
<tr><td colspan="2">Overarching Goals:
1) Apply mathematics to the physical world.
(2) Comprehend, understand, analyze, evaluate, critique, solve, and respond to a variety of real-life, meaningful problems.
(3) Investigate, research, and synthesize the societal impact of the study of physics.</td></tr>
<tr><td colspan="2">Goal 7: the students will be able to analyze the motion of an object using conservation of momentum.</td></tr>
<tr><td>Essential Questions:

• What can happen to energy during a collision?

• What are the social impacts of using impulse, momentum, and momentum conservation to analyze the motion of an object?

Enduring Understanding:

The mass and speed of an object are considered together (momentum) when determining the dynamic and kinematic effects on an object.

It takes a combination of force and time to change momentum.

Newton's 2nd Law (F=ma) can be used to predict the change in momentum for objects.</td><td>Learning Activities:

Tell students to imagine they are a scientist who wants to develop mathematical models that describe the motion and energy involved in different types of collisions. Use the Interactive Physics program to make observations of the objects' momenta and energy before and after each collision. Students should record any data, patterns, and conclusions. They should test their mathematical models to ensure they make correct predictions. Upon completion they should share their conclusions with their peers to see if they are in agreement.
(Comprehension, Analysis, Synthesis)

Assessment Models:

Tell students to imagine they are engineers given the task of creating a container that will protect an egg from breaking if it is dropped from</td></tr>
</table>

7.6. Draw diagrams to analyze the momentum of two bodies before and after a collision. (5.2.12.D.4, 5.1.12.D.2) 7.7. Describe the social, historical, political, philosophical, and economic impacts of analyzing momentum. (5.1.12.C.2, 5.1.12.C.3)	Disregarding outside forces, momentum is conserved when two or more objects come in contact. Energy is conserved in an elastic collision but lost in an inelastic collision.	the second story of a building down to the ground below. They must "pay" for their materials so they want it to be cost efficient as well. They should draw a labeled sketch of their design and explain how it will protect the egg using physics terms. They must observe their egg descending when it is dropped and the collision between the egg and ground. They should suggest improvements that could be made to their design if they were to build it again. *(Analysis, Evaluation, Synthesis)* **Other Assessment Models:** Formative assessment s will be used to assess transfer of knowledge. A summative assessment will be given at the conclusion of this unit. **Additional resources:** https://onlineservice1.progressive.com/inter actcgi/ rc/vown/rc_crash_videos.asp?cntgrp=Q http://pirt.asu.edu/detail_10.asp?ID=1065 Zitzewitz, Paul W. (1999). *Physics – Principles and Problems.* New York: Glencoe Kennedy, Daniel. (2010). Calculus- Graphical, Numerical, Algebraic. Boston: Prentice Hall Larson, Ron. (2009). Calculus of a Single Variable. New York: Houghton Mifflin Company http://www.design-simulation.com/ip/index.php

Curriculum Management System – Big Idea 8

<table>
<tr><td>Subject/ Grade level
Physics (11-12)</td><td colspan="2">Suggested days of instruction: 20</td></tr>
<tr><td rowspan="5">Quarter 4
Objective/ Cluster Concept/ Cumulative Progress Indicators

The student will be able to:
8.1. Relate the structure of an atom to conductors and insulators. (5.2.12.A.1)

8.2. Distinguish between charging by grounding, contact, induction, and polarization for conductors and insulators. (5.2.12.A.1)

8.3. Apply Coulomb’s Law to determine the net electric force acting on a charge with forces acting in two dimensions. (5.2.12.E.3)

8.4. Calculate the net electric field strength at the location of a point charge with electric fields in two dimensions. (5.2.12.E.3)

8.5. Draw charge diagrams to analyze the movement of electrons within a system. (5.2.12.A.1)</td><td colspan="2">Big Idea 8</td></tr>
<tr><td colspan="2">Topic: Electric Forces and Fields</td></tr>
<tr><td colspan="2">Overarching Goals:
(1) Apply mathematics to the physical world.
(2) Comprehend, understand, analyze, evaluate, critique, solve, and respond to a variety of real-life, meaningful problems.
(3) Investigate, research, and synthesize the societal impact of the study of physics.</td></tr>
<tr><td colspan="2">Goal 1: The students will be able to analyze the forces and electric fields acting on charges.</td></tr>
<tr><td>Essential Questions:

• How can kinematics and dynamics be applied to electrostatics?

• How can charges interact with other charges?

Enduring Understanding:

Electric charge is always quantized and is always conserved in a closed system but can be transferred from one object to another.

Concepts in kinematics and dynamics are applicable to other areas of physics such as electrostatics.

Coulomb’s Law and the understanding of electric fields were fundamental to later scientists in the development of electromagnetism which has social and economic outcomes.</td><td>Learning Activities:

Tell students to imagine they are a scientist trying to discover how charged objects interact with each other and with neutral objects. They will go to various stations in the classroom to see how the negatively charged rod rubbed with rabbit fur interacts with other objects. They should record their observations of the interactions and draw a charge diagram to accompany each interaction. They will be assigned one station to present their findings to their peers.

(Comprehension, Application, Analysis)

Assessment Models:

Formative assessments will be used to assess transfer of knowledge. A summative assessment will be given at the conclusion of this unit.</td></tr>
</table>

8.6. Draw free-body diagrams to analyze the net electric force and net electric field acting on a charge. (5.2.12.E.3) 8.7. Analyze electric field diagrams. (5.2.12.E.3) 8.8. Describe the social, historical, political, philosophical, and economic impacts of analyzing electrostatics. (5.1.12.C.2, 5.1.12.C.3)		**Additional resources:** http://www.livescience.com/environment/lightning_science.html http://www.aces.edu/dept/extcomm/newspaper/nov11b03.html http://www.lightningsafety.com/nlsi_pls/vehicle_strike.html http://www.its.caltech.edu/~phys1/java/phys1/EField/EField.html Zitzewitz, Paul W. (1999). *Physics – Principles and Problems.* New York: Glencoe Kennedy, Daniel. (2010). Calculus- Graphical, Numerical, Algebraic. Boston: Prentice Hall Larson, Ron. (2009). Calculus of a Single Variable. New York: Houghton Mifflin Company http://www.design-simulation.com/ip/index.php

Curriculum Management System – Big Idea 9

<table>
<tr><td>Subject/ Grade level
Physics (11-12)</td><td colspan="2">Suggested days of instruction: 18</td></tr>
<tr><td rowspan="5">Quarter 4
Objective/ Cluster Concept/ Cumulative Progress Indicators

The student will be able to:
9.1. Relate voltage to electric potential energy and electric charge and perform calculations using this relationship. (5.2.8.C.2)

9.2. Apply the relationship between current, charge, and time. (5.2.6.D.1)

9.3. Apply Ohm's Law to analyze the resistance of a material and the current flowing through it. (5.2.6.D.1, 5.1.12.B.1)

9.4. Distinguish between direct and alternating current. (5.2.6.D.1)

9.5. Relate electrical power to mechanical power. (5.2.8.C.2)

9.6. Explain how various factors affect the resistance of a material. (5.2.12.C.2,</td><td colspan="2">Big Idea 9</td></tr>
<tr><td colspan="2">Topic: Electric Energy, Current, and Resistance</td></tr>
<tr><td colspan="2">Overarching Goals:
(1) Apply mathematics to the physical world.
(2) Comprehend, understand, analyze, evaluate, critique, solve, and respond to a variety of real-life, meaningful problems.
(3) Investigate, research, and synthesize the societal impact of the study of physics.</td></tr>
<tr><td colspan="2">Goal 9: The students will be able to analyze the motion of electric charge in a current.</td></tr>
<tr><td>Essential Questions:

• What can affect current and resistance?

• Why is it important to understand the mathematics of an electrical energy bill?

• What impacts has mass distribution of electrical energy had on society?

Enduring Understanding:

An electric potential difference and closed conducting path are necessary to create an electric current.

Various factors affect the current traveling through and the resistance of a material.

Understanding the electric bill and the cost of running loads can lead to more energy efficient lifestyles.</td><td>Learning Activities:
Part 1: Tell students to imagine they are a scientist who wants to understand how batteries operate. Use a piece of steel wool and a 1.5 V D-cell battery to make the steel wool heat up or even spark.
<u>Caution</u>: They should never try this at home. After they have been successful combine their battery and steel wool with that of 5 other groups. They should record their observations. Students should analyze what they have just observed and answer the following questions:

- How must the wool be connected to the battery to result in heat? Draw a model to analyze the path of the flowing electrons.
- How does adding batteries together positive to negative end affect the total voltage and total amount of energy?
- Why is it dangerous to connect only a wire to either end of a battery?
(Knowledge, Comprehension, Analysis)

Part 2:
They now want to discover how a light bulb works. Students should build 4 different ways to</td></tr>
</table>

9.7. Calculate the cost of running various loads. (5.2.6.D.1) 9.8. Describe the social, historical, political, philosophical, and economic impacts of current electricity. (5.1.12.C.2, 5.1.12.C.3)		light a bulb using only 1 wire, 1 battery, and 1 light bulb. After completion draw a picture of each setup. Determine what requirements are necessary to light a bulb? *(Knowledge, Comprehension, Analysis)* **Assessment Models:** Tell students to imagine they are in charge of making sure their home goes “green.” Students should get a copy of their electric bill from their parents to determine the cost of energy from their supplier. They will calculate the cost of running at least 6 appliances in their home for a month.Research, using the internet, the power of cost efficient appliances similar to those they found in their home to see if their appliances are “green.” Compare the cost of running one of their non-green appliances for 10 years to a green appliance for 10 years. Ask students what types of things their family could do to be more energy efficient? Students should present their findings to their parents, peers, and teachers. *(Application, Analysis, Evaluation)* Tell students to imagine they work for a company that manufactures resistors. Their boss wants them to use an ammeter and voltmeter to determine the resistance of two new resistors. They must take multiple measurements to please him and present their findings in a formal lab report. *(Application, Analysis)* A comprehensive formative assessment will be given at the conclusion of this unit to assess transfer of knowledge.

Curriculum Management System Big Idea 10

<table>
<tr><td>Subject/ Grade level
Physics (11-12)</td><td colspan="2">Suggested days of instruction: 10</td></tr>
<tr><td rowspan="5">Quarter 4
Objective/ Cluster Concept/ Cumulative Progress Indicators

The student will be able to:
10.1. Explain how current flows through a series circuit versus and parallel circuit. (5.2.6.D.1)

10.2. Explain how voltage is divided between loads connected in series and parallel. (5.2.8.C.2, 5.2.6.D.1)

10.3. Find the equivalent resistance of resistors connected in series and resistors connected in parallel. (5.2.6.D.1)

10.4. Apply Ohm’s Law to analyze the current and voltage at various points in a series and parallel circuit. (5.2.8.C.2)

10.5. Apply Kirchhoff’s Laws to analyze the current and voltage at various point in a series and parallel circuit.</td><td colspan="2">Big Idea 10 Analyze</td></tr>
<tr><td colspan="2">Topic: Circuits</td></tr>
<tr><td colspan="2">Overarching Goals:
(1) Apply mathematics to the physical world.
(2) Comprehend, understand, analyze, evaluate, critique, solve, and respond to a variety of real-life, meaningful problems.
(3) Investigate, research, and synthesize the societal impact of the study of physics.</td></tr>
<tr><td colspan="2">Goal 10: The student will be able to analyze the motion of charge in series and parallel circuits.</td></tr>
<tr><td>Essential Questions:

• Why are schematic diagrams important?

• How can series and parallel circuit combinations affect the power output of a load?

• What are the social and economic impacts of electric circuits?

Enduring Understanding:
Circuits can contain various types of loads connected in series and parallel combinations which can be represented in a schematic diagram.
The equivalent resistance of a circuit can be found by combining resistors connected in series and parallel.
Ohm’s Law and Kirchhoff’s Laws can be applied to complex circuits to analyze the current, voltage, and resistance at various parts of a circuit.
The power output of a load can change depending on its connection to the power source (series/parallel).
Electric circuits have social, historical, political, and economic outcomes.</td><td>Learning Activities:

Tell students to imagine they are electricians. They will be given various sets of parameters for which 4 circuits must abide by then they will build each circuit. Students should draw a schematic diagram of each circuit and describe the connection between each light bulb as series or parallel.
(Application, Analysis, Synthesis)

Learning Activity #2:
Tell students to imagine they are scientists who want to understand how current and voltage work in a series and parallel circuit. They should use an ammeter and voltmeter to measure the current and voltage at various parts of 3 different circuits and 3 different parallel circuits. They should record their observations and any patterns they observe. Use their conclusions to predict how the current and voltage will work in a different circuit from what they have already built. Students should test their predictions and make any necessary adjustments to their conclusions.</td></tr>
</table>

(optional) (5.1.12.A.1, 5.1.12.A.3, 5.1.12.B.1, 5.2.6.D.1) 10.6. Describe the social, historical, political, philosophical, and economic impacts of building and analyzing electric circuits. (5.1.12.C.2, 5.1.12.C.3) 10.7. Interpret and construct schematic diagrams. (5.1.12.D.1, 5.1.12.D.2)		*(Analysis, Synthesis, Evaluation)* **Assessment Models:** Formative assessments will be used to assess transfer of knowledge. A summative assessment including information from the previous unit will be given at the conclusion of this unit. Physics Portfolio assessment s (notes, labs) & Project-based assessments will serve and factor as additional cumulative representations of student work. **Additional resources:** Zitzewitz, Paul W. (1999). *Physics – Principles and Problems.* New York: Glencoe Kennedy, Daniel. (2010). Calculus- Graphical, Numerical, Algebraic. Boston: Prentice Hall Larson, Ron. (2009). Calculus of a Single Variable. New York: Houghton Mifflin Company http://www.design-simulation.com/ip/index.php

Physics

COURSE BENCHMARKS

1. The student will be able to analyze the motion of objects moving horizontally or vertically with a constant velocity or constant acceleration.
2. The student will be able to analyze the motion of projectiles.
3. The student will be able to analyze a problem involving vector addition.
4. The student will be able to apply Newton's Laws of motion to analyze the motion of various objects and the forces acting on them.
5. The student will be able to analyze the motion of rotating and revolving objects.
6. The student will be able to analyze the motion of an object using energy conservation and the work-energy theorem.
7. The student will be able to analyze the motion of an object using conservation of momentum.
8. The student will be able to analyze the forces and electric fields acting on charges.
9. The student will be able to analyze the motion of electric charge in a current.
10. The student will be able to analyze the motion of charge in series and parallel circuits.

QUARTERLY BENCHMARKS

1st Quarter: Summative assessment in the form of a test and project-based assessment models.
2nd Quarter: Midyear summative assessment in the form of a test. Questions will focus on material from the 2nd quarter but will incorporate material from the 1st quarter and will incorporated project-based assessment models.
3rd Quarter: Summative assessment in the form of a test. Questions will focus on material covered in the 3rd quarter and will incorporate project-based assessment models.
4th Quarter: Final Examination. Physics Portfolios & Project-based assessments will serve as additional representations of student