***Subject:*** Physics

**Unit**: **Vectors and Scalars; Motion In One and Two Dimension** **Grade Level:** 10-12

***Designed by:*** Andrew Neely

***School District:*** Tunkhannock Area **School:** High School

***Brief Summary of Unit:***

Physics represents the human urge to make sense of the physical universe that surrounds us; to write the rules of its workings in exacting and comprehensible terms, for to study physics is to study the mechanism of the universe. Professional physicists find that they must resort to higher mathematics in order to formulate their theories and explain their findings. For this reason, most of the new developments in physics, the advancing front of human and scientific knowledge, are well beyond the comprehension of the beginning student. But the basics on which the great superstructure of physical theory is built are accessible to anyone with reasonable grasp of elementary algebra, trigonometry, and the desire to understand. The overall aim of the physics program is not merely to present ideas, concepts, and hone mathematical skills, but to kindle a deep desire to extend the horizons of one's understandings of the universe that surrounds us.

In this unit on scalars, vectors, and motion, students will differentiate between scalar and vector quantities. Students will also understand the relationship between quantities, their symbols, and their dimensions.

Students will Identify and know metric SI and English measurement units, have working skills with scientific notation, use dimensional analysis, be familiar with the nomenclature of physics, write, derive, and use equations in problem solving situations.

Students will understand the nature of Classical or Newtonian Mechanics, including
A. Know, understand, and apply vectors and vector methods in problem solving.
B. Understand and work with the concepts of velocity and acceleration in one and two-dimensional motion.

**Extension Activities for Accelerated Students:** Additional high-level problems.

**Differentiated Activities for Non-advanced Students:** Remediation with problem solving strategies, extra lower-level problems.

**I.** **Unit #: NEWTONIAN MECHANICS**

**II.** **Unit 2: Vectors and Scalars; Motion In One Dimension**

**Section**

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| 3.2.P.B1.<br>Differentiate among translational motion in terms of position, **velocity**, and acceleration. |

***Overarching Understandings***

- Students should understand the general relationships among position, velocity, and acceleration for the motion of a particle along a straight line, so that:
- Students should understand the special case of motion with constant acceleration, so they can:

| Topical Understanding | Essential Questions |
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| • Distinguish between (i) displacement and distance, (ii) speed and velocity, and (iii) average speed and instantaneous speed.<br>• Define displacement and average speed of a motion of a particle.<br>• Relate average speed to distance traveled and time elapsed in order to solve practical problems involving such parameters.<br>• Distinguish and define speed as a scalar quantity and velocity as a vector quantity.<br>• Define the acceleration of a particle.<br>• State two conditions that are necessary if motion is to be described as uniformly accelerated motion.<br>• Define acceleration and average velocity and suggest means for measuring them.<br>• Write five general equations involving distance, initial | (1) Given a graph of one of the kinematic quantities, position, velocity, or acceleration, as a function of time, can students recognize in what time intervals the other two are positive, negative, or zero and can students identify or sketch a graph of each as a function of time?<br>(2) Given an expression for one of the kinematic quantities, position, velocity or acceleration, as a function of time, can students determine the other two as a function of time, and find when these quantities are zero or achieve their maximum and minimum values? |

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| velocity, final velocity, acceleration, and time.<br>• Solve for any of two parameters of the five parameters mentioned above when the others are given.<br>• Apply the equations of kinematics to any situation where the motion occurs under constant acceleration.<br>• Write the value of the acceleration due to gravity in the SI and the FPS Systems.<br>• Describe what a body in free fall means. Recognize that the equations of kinematics apply to free-fall.<br>• Predict the position and the velocity at specific times for a body dropped from rest or projected vertically upwards with an initial velocity.<br>• Perform a unit analysis for each equation developed in the unit and prove that they are dimensionally correct.<br>• Construct and analyze position and time and speed and time graphs for both kinematics and free fall. | |
| **Knowledge** | **Skills** |
| **A. Kinematics (including vectors, vector algebra, components of vectors, coordinate systems, displacement, velocity, and acceleration)**<br>3-1 One Dimensional Motion.<br>A. Rectilinear or linear motion.<br>B. Speed as a scalar.<br>C. Velocity as a vector.<br>D. Average speed and velocity.<br>3-2 Accelerated Motion.<br>A. Uniform acceleration.<br>B. Non-uniform acceleration.<br>3-3 Derivations of the Equations of Linear Motion.<br>3-4 Applications of the Equations to Linear Motion.<br>A. Frames of reference.<br>B. Problem strategy.<br>C. Problem procedures.<br>3-5 The Earth's Gravitational Field and Free Fall.<br>A. Effects on bodies projected vertically downward.<br>B. Effects on bodies projected vertically upward.<br>3-6 Applications of the Principles of Kinematics to Free Fall.<br>A. Derivation of the Equations of Free Fall. | Students will be able to calculate and apply the Acceleration due to Gravity to free fall problems.<br><br>Students will apply fundamental ideas of calculus to Analyze Motion Graphs.<br><br>Apply algebraic concepts, such as solving quadratic equations, to Uniformly Accelerated Motion problems.<br><br>Students will be able to graph and analyze Accelerated motion on an Air Track. |

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| B. Motion along the vertical axis. | |

**Unit #: Unit 3: Motion In One and Two Dimensions** **Section**

3.2.P.B1.
Differentiate among translational motion in terms of position, **velocity**, and acceleration.

**S11.C.3.1.3** Explain that acceleration is the rate at which the velocity of an object is changing.

***Overarching Understandings***

- Students should be able to add, subtract, and resolve displacement and velocity vectors, so they can:
- Students should analyze the motion of projectiles in a uniform gravitational field, so they can:

| **Topical Understanding** | **Essential Questions** |
|---|---|
| • **Analyze Motion in two dimensions, including projectile motion**<br>• Differentiate between one and two-dimensional motion.<br>• Discuss the trajectory of a projectile under the influence of the earth's gravitational field, a vector field.<br>• Explain graphically how the motion of a horizontally projected ball compares with that of a ball dropped from rest.<br>• Explain with diagrams how the vertical motion of a projectile fired at any angle is similar to the motion of a ball projected vertically.<br>• Demonstrate that all derived equations developed in projectile motion are dimensionally correct.<br>• Predict the position and velocity of a projectile as a function of time and its projection angle and initial velocity are given.<br>• Determine the range, maximum altitude, and time of flight for a given projectile when the initial speed and the angle of projection are given. | Given a projectile fired at an angle, can students calculate initial velocity, time of flight, and displacement?<br><br>When given a vector, can students resolve the vector into horizontal and vertical components? |
| **Knowledge** | **Skills** |

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| **A. Kinematics (including vectors, vector algebra, components of vectors, coordinate systems, displacement, velocity, and acceleration)**<br>3-7 Motion in 2-Dimensional Space.<br>A. The effects of gravity on 2-D motion.<br>B. Projectiles.<br>C. Trajectories.<br>3-8 Factors Affecting The Trajectory of a Projectile.<br>A. Angle of projection into 2-D space.<br>B. Initial speed of the projectile.<br>C. The earth's gravitational field.<br>3-9 Derivation of the Equations of Projectile Motion.<br>A. Velocity as a vector and its components.<br>B. Velocity as a function of time.<br>C. Maximum altitude equation.<br>D. Time of flight equation.<br>E. The range equation.<br>F. Altitude as a function of horizontal distance.<br>G. Quadratic time equation.<br>H. Velocity and angle of impact. | • Students will be able to calculate the initial velocity, displacement, and time of fall for projectiles fired at angles.<br>• Students will be able to calculate the initial velocity, maximum height, and time to reach maximum height for projectiles fired at angles.<br>• Calculate components of a vector along two specified, mutually perpendicular axes.<br>• Calculate the net displacement of a particle or the location of a particle relative to another.<br>• Calculate the change in velocity of a particle or the velocity of one particle relative to another.<br>• Derive expressions for the horizontal and vertical components of velocity and position as functions of time, and sketch or identify graphs of these components.<br>• Use the fundamental kinematics equations when analyzing the motion of a projectile that is projected with an arbitrary initial velocity. |

***Subject:*** Physics

**Unit**: **Unit 4: Newton's Laws of Motion** **Grade Level:** 10-12

***Designed by:*** Andrew Neely

***School District:*** Tunkhannock Area ***School:*** High School

***Brief Summary of Unit:***

In this unit, students will study, both qualitatively and quantitatively, Newton's Three Laws of Motion and the Universal Law of Gravitation, including their direct application to moving and non-moving systems.

Students will also be able to:

Describe and solve problems stemming from systems in static and translational equilibrium.

Understand the concepts of mass and weight.

Use technology to assist in experimentation and problem-solving.

Know that there may be several approaches in solving the same problem.

Know how to interpret data and graphs and draw conclusions

Know how to report experimental results in a scientific manner (concise and logical conclusions)

**Extension Activities for Accelerated Students:** Additional high-level problems.

**Differentiated Activities for Non-advanced Students:** Remediation with problem solving strategies, extra lower-level problems.

3.2.P.B1. Use force and **mass** to explain translational motion
3.2.P.B6. PATTERNS SCALE MODELS CONSTANCY/CHANGE
Use Newton's laws of motion and gravitation to describe and predict the motion of objects ranging from atoms to the galaxies.

***Overarching Understandings***

- Students should be able to analyze situations in which a particle remains at rest, or moves with constant velocity, under the influence of several forces.
- Students should differentiate between the force that acts on an object and the resulting change in the object's velocity, so they can:
- Students should apply Newton's Second Law to an object subjected to forces such as gravity, the pull of strings, or contact forces, so they can:
- Students should be able to analyze situations in which an object moves with specified acceleration under the influence of one or more forces so they can determine the magnitude and direction of the net force, or of one of the forces that makes up the net force, such as motion up or down with constant acceleration.
- Students should understand the significance of the coefficient of friction, so they can:
- Students should be able to apply Newton's Third Law in analyzing the force of contact between two objects that accelerate together along a horizontal or vertical line, or between two surfaces that slide across one another.

| **Topical Understanding** | **Essential Questions** |
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| • Experimentally demonstrate his/her understanding of Newton's First Law of Motion.<br>• Give several examples with appropriate discussion to illustrate his/her understanding of Newton's Third Law of Motion.<br>• State the First Condition of Equilibrium both verbally and mathematically, give a physical example, and demonstrate graphically that the First Condition is satisfied.<br>• Construct a free-body diagram representing all forces acting on an object that is in translational equilibrium.<br>• Apply the First Condition of Equilibrium to set up two equations involving components of given vectors along the x-axis and the y-axis of a frame of reference.<br>• Solve the simultaneous equations derived from the First | A. For an object moving in one dimension, can students calculate the velocity change that results when a constant force *F* acts over a specified time interval?<br>B. Can students derive the vector equation that results from applying Newton's Second Law to the object, and take components of this equation along appropriate axes?<br>C. Given an object on an inclined plane, can students analyze and calculate frictional forces and net forces that may cause accelerations? |

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| Condition for unknown forces.<br>• Define the forces of kinetic friction and static friction and suggest a means of measuring them.<br>• Write a theoretical relationship for calculating frictional forces and apply this relationship to the solution of general force situations involving the use of vectors.<br>• Define the limiting angle of repose for the two surfaces involved along an inclined plane and to generate methods of vector solutions of inclined plane problems.<br>• State Newton's Second Law of Motion verbally and in the form of a mathematical statement.<br>• Write the units of force, mass, and acceleration in SI, cgs, FPS units.<br>• Define the units Newton and slug and to be able to express them in SI, cgs, and FPS units.<br>• Describe and conduct experiments that would show the variations in acceleration produced by a change in applied force or by a change in the mass that is being accelerated.<br>• Demonstrate by definition and example an understanding of the distinction between mass and weight.<br>• Use Newton's Universal Law of Gravitation to derive the acceleration due to gravity for the Earth's surface and for the surfaces of other planets where the radius and the mass of the planet are given.<br>• Use Newton's Universal Law and Newton's Second Law of Motion to express weight and other mathematical concepts for any location in the universe.<br>• Determine mass from weight or weight from mass where a value for the acceleration due to gravity is known<br>• Draw a free-body diagram for a body or a system of bodies in motion with a constant acceleration, set the resultant force equal to the total mass times the acceleration, and solve for the unknown parameters. | |
| **Knowledge** | **Skills** |

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| **Newton’s laws of motion**<br>4.1 Newton's First Law of Motion—Inertia.<br>4.2 Newton's Third Law of Motion.<br>4.3 Conditions Necessary for Equilibrium.<br>4.4 The First Condition of Equilibrium.<br>4.5 Applications of the First Condition.<br>4.6 Friction in a Mechanical System.<br>A. Static friction.<br>B. Kinetic friction.<br>4.7 The Inclined Plane as a Physical System with Zero Acceleration.<br>4.8 Newton's Universal Law of Gravitation—A First Look.<br>A. Inverse square law.<br>B. The acceleration due to gravity on the Earth.<br>C. The acceleration due to gravity on other planets.<br>4.9 Mass and Gravitational Weight.<br>4.10 Resultant Force and Non-Equilibrium.<br>4.11 Newton's Second Law of Motion—The Study of Dynamics.<br>A. SI unit: N (Newton)<br>B. cgs unit: dyne<br>C. FPS units: lb (pound)<br>D. The slug as a unit of mass.<br>4.12 Single Body Application of Newton's 2nd Law.<br>● 4.13 Application of Newton's 2nd Law to Systems of Bodies. | A. Draw a well-labeled, free-body diagram showing all real forces that act on the object.<br>B. Derive the relationship between the normal and frictional forces on a surface.<br>C. Analyze situations in which an object moves along a rough inclined plane or horizontal surface.<br>D. Analyze under what circumstances an object will start to slip, or to calculate the magnitude of the force of static friction.<br>E. Students should be able to solve problems in which application of Newton’s laws leads to two or three simultaneous linear equations involving unknown forces or accelerations. |

***Subject:*** Physics

**Unit**: **Unit 5: Work, Energy, and Power** **Grade Level:** 10-12

***Designed by:*** Andrew Neely

***School District:*** Tunkhannock Area ***School:*** High School

***Brief Summary of Unit:***

In this unit the students will have a working knowledge of the Work-Energy Theorem and the Law of Conservation of Energy for both conservative and non-conservative systems.

Laboratory work will include:

The use of technology to assist in experimentation and problem-solving.

Drawing upon past knowledge to realize that there may be several approaches in solving the same problem.

Know how to interpret data and graphs and draw conclusions

Know how to report experimental results in a scientific manner (concise and logical conclusions)

**Extension Activities for Accelerated Students:** Additional high-level problems.

**Differentiated Activities for Non-advanced Students:** Remediation with problem solving strategies, extra lower-level problems.

3.2.P.B2.
Explain the translation motion of objects using conservation of energy

**S11.C.3.1.5** Calculate the mechanical advantage of moving an object using a simple machine.

**S11.C.3.1.2** Design or evaluate simple technological or natural systems that incorporate the principles of force and motion (e.g., simple machines, compound machines).

**S11.C.3.1.6** Identify elements of simple machines in compound machines.

***Overarching Understandings***

- Have a working knowledge of the Work-Energy Theorem and the Law of Conservation of Energy for both conservative and non-conservative systems.

| **Topical Understanding** | **Essential Questions** |
| --- | --- |
| • State the conditions necessary for the performance of physical work.<br>• Give two examples of an applied force that does no physical work and give one example of a displacement that occurs with the performance of work.<br>• Write a mathematical statement for calculating the work accomplished by a given force and demonstrate that the equation is dimensionally correct.<br>• Define the foot-pound, the joule, and the erg as FPS, SI, and cgs units of both work and energy.<br>• Illustrate the developed understanding of energy by giving two examples of systems using (i) potential energy; (ii) kinetic energy, and (iii) total energy.<br>• Demonstrate by example and by experiment the relationship between the performance of work and the corresponding change in kinetic energy. | • How is energy transferred from one form to another? |

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| • Calculate the kinetic energy of a body when its mass or weight is given.<br>• Write an equation that will determine the gravitational potential energy of a known mass or weight relative to a given location in space.<br>• State verbally and mathematically the principle of the Law of Conservation of Mechanical Energy concluding with an example.<br>• Relate the initial and final energy states of a system to physical situations.<br>• Demonstrate by example and by experiment the use of the power concept and a procedure or computation.<br>• Define and compare the units of kilowatt and the horsepower as they are defined to measure power. | |
| **Knowledge** | **Skills** |
| 5.1 Physical Work.<br>5.2 Gravitational Potential Energy.<br>5.3 Work and Gravitational Potential Energy.<br>5.4 Kinetic Energy.<br>A. Units are the same as work units.<br>B. Relationship between kinetic energy, potential energy, and work.<br>5.5 Total Mechanical Energy.<br>A. Closed systems.<br>B. Sum of mechanical energy in a closed system is a constant.<br>C. Energy transformation.<br>5.6 The Classical Law of Conservation of Energy.<br>5.7 The Time Rate of Doing Work—Power. | Calculate Human Horsepower on the Stairs.<br><br>Explore Work and Energy Using the Inclined Plane<br><br>Explore Hooke’s Law with different springs.<br><br>Calculate the Mechanical Advantage and Efficiency of a system of Pulleys |

***Subject:*** Physics

**Unit**: **Unit 6: Momentum and Collision** **Grade Level:** 10-12

***Designed by:*** Andrew Neely

***School District:*** Tunkhannock Area ***School:*** High School

***Brief Summary of Unit:***

In this unit the students will know, understand, and apply the concepts of momentum and impulse in the behavior of physical systems.

Students will both qualitatively and quantitatively differentiate between the three types of collisions: Elastic, Inelastic, and Totally Inelastic.

Laboratory work will include:

The use of technology to assist in experimentation and problem-solving.

Drawing upon past knowledge to realize that there may be several approaches in solving the same problem.

Know how to interpret data and graphs and draw conclusions

Know how to report experimental results in a scientific manner (concise and logical conclusions)

**Extension Activities for Accelerated Students:** Additional high-level problems.

**Differentiated Activities for Non-advanced Students:** Remediation with problem solving strategies, extra lower-level problems.

**Unit #: Unit 6: Momentum and Collision** **Section**

3.2.P.B2.
Explain the translational motion of objects using conservation of momentum.

**S11.C.3.1.1** Explain common phenomena (e.g., motion of bowling ball, a rock in a landslide, an astronaut during a space walk, a car hitting a patch of ice on the road) using an understanding of conservation of momentum.

***Overarching Understandings***

- Know, understand, and apply the concepts of momentum and impulse in the behavior of physical systems.

| **Topical Understanding** | **Essential Questions** |
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| • Define impulse and momentum and suggest means for their measurement.<br>• Write an equation illustrating the relationship of a change in momentum to the impulse and show that the relationship is dimensionally correct.<br>• Demonstrate by example and by experiment the validity of the Law of Conservation of Momentum.<br>• Apply the Law of Conservation of Momentum to problem situations involving colliding bodies and systems of colliding bodies.<br>• Use the understanding of energy and momentum to explain what occurs after a collision process has stopped.<br>• Design an experiment that will measure the coefficient of restitution. | • How is momentum transferred from one object to another during a collision? |

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| • Distinguish by definition and by example between totally inelastic, partially elastic, and perfectly elastic collisions.<br>• Predict the velocities of two colliding bodies after impact when the coefficient of restitution, masses, and velocities before impact are given. | |
| **Knowledge** | **Skills** |
| 6.1 Newton's Second and Third Laws and Impulse.<br>6.2 Momentum and Impulse.<br>6.3 The Law of Conservation of Momentum.<br>6.4 Collisions.<br>A. The coefficient of restitution.<br>B. Conservative and non-conservative collisions.<br>C. Conditions for non-conservation.<br>D. Non-contact collisions.<br>E. Contact collision types.<br>6.5 Energy and Work in the Collision Process. | Qualitatively explore Conservation of Linear Momentum on the Air Track<br><br>Use the Ballistic Pendulum and Conservation of Linear Momentum to find the initial speed of a projectile<br><br>Prove Conservation of Momentum with Momentum Carts (quantitative)<br><br>Calculate angles between Two-Dimensional Scattering Collisions |

***Subject:*** Physics

**Unit**: **Unit 7: Rotational Kinematics** **Grade Level:** 10-12

***Designed by:*** Andrew Neely

***School District:*** Tunkhannock Area ***School:*** High School

***Brief Summary of Unit:***

In this unit the students will be able to describe and work with systems in circular and rotational motion.

Students will also cite and create models that explain systems in both linear and rotational motion.

Laboratory work will include:

Drawing upon past knowledge to realize that there may be several approaches in solving the same problem.

Know how to interpret data and graphs and draw conclusions

Know how to report experimental results in a scientific manner (concise and logical conclusions)

**Extension Activities for Accelerated Students:** Additional high-level problems.

**Differentiated Activities for Non-advanced Students:** Remediation with problem solving strategies, extra lower-level problems.

**Unit #:** **Unit 7: Rotational Kinematics** **Section**

3.2.P.B2. Explain how gravitational, electrical, and magnetic forces and torques give rise to rotational motion.
**S11.A.3.3.3** Analyze physical patterns of motion to make predictions or draw conclusions (e.g., solar system, tectonic plates, weather systems, atomic motion, waves).

***Overarching Understandings***

- Be able to describe and work with systems in circular and rotational motion.

| **Topical Understanding** | **Essential Questions** |
|---|---|
| • State the conditions necessary for uniform circular motion.<br>• Explain how acceleration is possible without a change in speed.<br>• Calculate the centripetal acceleration of a rotating body.<br>• Derive the equations of rotational motion and compare them to the equations of linear motion.<br>• Demonstrate that all equations derived in this unit are dimensionally correct.<br>• Apply the developed understandings of centripetal force to examples of banked curves and motion in a vertical circle.<br>• Describe two practical applications of centripetal force.<br>• Write verbal and mathematical statements dealing with centripetal and centrifugal force noting the differences.<br>• Define and illustrate the degree, the radian, and the revolution as angular measure and be able to convert between them.<br>• Define angular velocity and angular acceleration and describe procedures for measuring them.<br>• State angular kinematic concepts in terms of linear kinematic terms and expressions. | • How does the study of centripetal forces apply to planetary motion? |
| **Knowledge** | **Skills** |

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| 7.1 Uniform Circular Motion.<br>A. Non-linear motion.<br>B. Acceleration due to change of direction.<br>C. Centripetal acceleration.<br>7.2 Newton's Second Law and Centripetal Force.<br>A. Center seeking force and acceleration.<br>B. Tangential velocity.<br>C. Motion in a horizontal circle.<br>7.3 The Banking of Highway Curves as an Application.<br>7.4 Motion in a Vertical Circle.<br>A. Non-constant acceleration.<br>B. Tangential acceleration.<br>C. Application to aircraft.<br>7.5 Angular displacement.<br>A. Angular speed and velocity.<br>B. Angular and linear velocities.<br>C. Angular acceleration.<br>D. Angular and linear accelerations.<br>Equations of rotational kinematics. | Qualitative and Quantitative observations for Stopper on a String<br><br>Draw elliptical orbits to examine Kepler's Laws<br><br>Use the planetarium to calculate the mass of the Sun and Earth based on observed data using Universal Gravitation |

***Subject:*** Physics

**Unit**: **Unit 17: Current and Resistance and Unit 18: Direct Current Circuits** **Grade Level:** 10-12

***Designed by:*** Andrew Neely

***School District:*** Tunkhannock Area ***School:*** High School

***Brief Summary of Unit:***

In this unit, students will be able to be able to demonstrate the existence of two kinds of charge and describe the quantization of electrical charge in terms of the elementary charge, e.

Students will also be familiar with the current through resistors and the potential and power drop across them individually, in series, and in parallel.

Students will become familiar with electrical circuits and the application of Ohm's Law and Kirchhoff''s Rules.

Laboratory work will include:

The use of technology to assist in experimentation and problem-solving.

Realizing that there may be several approaches in solving the same problem when dealing with more complex circuits.

Know how to interpret data and graphs and draw conclusions

Know how to report experimental results in a scientific manner (concise and logical conclusions)

**Extension Activities for Accelerated Students:** Additional high-level problems.

**Differentiated Activities for Non-advanced Students:** Remediation with problem solving strategies, extra lower-level problems.

Unit #: **Unit 17: Current and Resistance and Unit 18: Direct Current Circuits** **Section**

3.2.P.B4. Develop qualitative and quantitative understanding of current, voltage, resistance, and the connections among them.

**S11.C.2.1.4** Use Ohm's Law to explain resistance, current and electro-motive forces.

***Overarching Understandings***

- Be familiar with the current through resistors and the potential and power drop across them individually, in series, and in parallel.
- Be familiar with electrical circuits and the application of Ohm's Law and Kirchhoff''s Rules.

| Topical Understanding | Essential Questions |
|---|---|
| • Define the ampere as the unit of electrical current.<br>• Distinguish between electron flow and conventional flow.<br>• State Ohm's Law for electrical components and define the unit of resistance, the ohm.<br>• Compute the potential drop across a resistance carrying a given current.<br>• State four factors which determine the resistance of a given wire.<br>• Calculate the resistance of a wire given its length, diameter, and resistivity.<br>• Understand, on the atomic level, the effect of increased temperature on a resistance.<br>• Describe and compute the change in resistance of a given conductor with change in temperature.<br>• Relate the potential difference across a given resistance carrying a current to the energy loss in the resistance.<br>• Define the watt as the unit of electrical power.<br>• Calculate the power loss across a given current carrying resistance.<br>• Define electromotive force and the role it plays in DC electrical theory. | • How are Voltage, Current, and Resistance related to each other and calculated in series, parallel, and mixed circuits? |

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| • State Ohm's Law for an entire electrical circuit verbally and mathematically and apply it to the solution of problems involving internal battery resistance and total resistance of the circuit.<br>• Demonstrate Ohm's Law with a voltmeter, an ammeter, a rheostat, a source of emf, and appropriate lead wires and draw a schematic diagram of an electrical set-up, using appropriate symbols for the electrical used.<br>• Calculate resistance across a bank of resistors in series and parallel.<br>• Calculate total resistance of an entire circuit.<br>• Compute power loss in a given DC circuit.<br>• Connect resistors in series and in parallel and draw circuit diagrams for each connection.<br>• Write statements describing voltage, current, and equivalent resistance for resistors connected in series and resistors connected in parallel.<br>• Distinguish between emf and potential difference.<br>• Predict the terminal voltage, given the emf of a battery, its internal resistance, and the load resistance.<br>State and apply Kirchhoff's Law for electrical networks in the determination of unknown currents. | |
| **Knowledge** | **Skills** |
| 17.1 Current and Charge.<br>17.2 Ohm's Law.<br>17.3 Resistance and Resistivity.<br>17.4 Temperature Variation of Resistance.<br>17.5 Electrical Energy and Power.<br><br>18.1 The Electromotive Force, emf.<br>18.2 Resistors in Series and Parallel.<br>18.3 Ohm's Law for an Entire Circuit.<br>18.4 Internal Resistance and Terminal Voltage.<br>18.5 Voltmeters, Ammeters, and Galvanometers.<br>18.6 The Wheatstone Bridge. | Using circuit boards, design and measure Series vs Parallel Resistors<br><br>Experimentally determine Ohm's Law<br><br>Experimentally analyze Kirchhoff's Rules<br><br>Design a Wheatstone Bridge |

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| 18.7 Kirchhoff's Rules. | |

***Subject:*** Physics

**Unit**: **Unit 22: Reflection and Refraction of Light** **Grade Level:** 10-12

***Designed by:*** Andrew Neely

***School District:*** Tunkhannock Area ***School:*** High School

***Brief Summary of Unit:***

In this unit, students will write and demonstrate two laws that pertain to the reflection of light, demonstrate an understanding of the nature of images formed by plane mirrors, distinguish between virtual and real images, use ray-tracing techniques to construct images formed by spherical mirrors, apply the lens-maker equation to solve for unknown parameters related to the construction of lenses, design an experiment that would give the magnification of a given lens for a given distance.

Laboratory work will include:

Image formation with concave and convex lenses.

**Extension Activities for Accelerated Students:** Additional high-level problems.

**Differentiated Activities for Non-advanced Students:** Remediation with problem solving strategies, extra lower-level problems.

**Unit #: Unit 22: Reflection and Refraction of Light** **Section**

3.2.P.B5.
Explain how waves transfer energy without transferring matter.
Explain how waves carry information from remote sources that can be detected and interpreted.
Describe the causes of wave frequency, speed, and wave length.
**S11.C.2.1.1** Compare or analyze different types of waves in the electromagnetic spectrum (e.g., ultraviolet, infrared, visible light, x-rays, microwaves) as it relates to their properties, energy levels, and motion

***Overarching Understandings***

- Describe the characteristics of wave motion and behavior.
- Demonstrate a familiarity of wave motion in fluids.

| Topical Understanding | Essential Questions |
|---|---|
| • Give an example of Huygens's principle.<br>• Define index of refraction.<br>• Calculate frequency of given wavelengths of electromagnetic waves.<br>• Discuss the relationships between radio, infrared, visible, ultraviolet, x-rays, and gamma radiation.<br>• State Snell's Law.<br>• Define critical angle. | • What geometric principles allow for the reflection of light off different surfaces?<br>• What geometric principles allow for the refraction of light through different substances? |
| **Knowledge** | **Skills** |
| 22.1 The Nature of Light.<br>22.2 The Electromagnetic Waves.<br>22.3 The Electromagnetic Spectrum.<br>22.4 Reflection and Refraction.<br>22.5 The Law of Refraction.<br>22.6 Dispersion and the Prism. | Experimentally determine evidence of Reflection, Refraction, and Snell's Law<br><br>Evaluate uses for Index of Refraction of Glass |

Unit #: **Unit 23: Mirrors and Lenses** **Section**

3.2.P.B5.
Explain how waves transfer energy without transferring matter.
Explain how waves carry information from remote sources that can be detected and interpreted.
Describe the causes of wave frequency, speed, and wave length.

**S11.A.2.1.3** Use data to make inferences and predictions, or to draw conclusions, demonstrating understanding of experimental limits.

**S11.A.3.1.2**
Analyze and predict the effect of making a change in one part of a system on the system as a whole.

***Overarching Understandings***

- Be able to describe the image formed due to reflection and refraction of light: Real/Virtual, Inverted/Upright, and Magnified/Reduced/Same Size.

| **Topical Understanding** | **Essential Questions** |
|---|---|
| • Write and demonstrate two laws that pertain to the reflection of light.<br>• Demonstrate an understanding of the nature of images formed by plane mirrors.<br>• Distinguish between virtual and real images.<br>• Use ray-tracing techniques to construct images formed by spherical mirrors.<br>• Apply the lens-maker equation to solve for unknown parameters related to the construction of lenses.<br>• Design an experiment that would give the magnification of a given lens for a given distance. | • What geometric principles allow for the formation of real and virtual images when light reflects and refracts? |
| **Knowledge** | **Skills** |
| 23.1 Plane Mirrors.<br>23.2 Spherical Mirrors.<br>A. Concave.<br>B. Convex.<br>23.3 Ray Tracing. | Qualitatively explore Mirror Optics and differentiate between Concave and Convex<br><br>Calculate Focal Length of various Lenses |

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| 23.4 Images formed by Refraction.<br>23.5 Thin Lenses. | |

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| ***Students will be able to use their learning independently to:***<br>• |

| **Big Idea(s)** | **Essential Questions** |
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| **Knowledge** | **Skills** |
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| ***Students will be able to use their learning independently to:*** <br>• |

| Big Idea(s) | Essential Questions |
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| **Big Idea(s)** | **Essential Questions** |
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| ***Students will be able to use their learning independently to:*** <br>• |

| Big Idea(s) | Essential Questions |
|---|---|
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| **Knowledge** | **Skills** |
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