Academic Physics

Algebra/Trigonometry-Based First Year Physics Course.

The main goal of this course is to provide those students considering entering a STEM career field (science, technology, engineering, and mathematics) with a challenging, yet clear and logical presentation of the principles of physics. They will engage in the methods used by physicists to explain and predict the fundamental functions of the physical world both descriptively and mathematically.

The topics of study will include:

- Scientific methods of experimentation.
- Analysis and application of the Newtonian Laws of Motion to include linear, free fall, two-dimensional, circular, and projectile motions.
- Simple Harmonic Motion (repetitive vibrations)
- Statics (Bodies in Equilibrium)
- Analysis of rotational and circular motion utilizing torque and angular momentum.
- Newton’s Universal Law of Gravity and orbital motion.
- Conservation of Momentum in collisions.
- Conservation of Energy and work done on/by systems.
- Principles and applications of Thermodynamics (heat energy)
- The nature and behavior of fluid dynamics.
- The wave nature of light and sound including applications in technology.
- Principles and Applications of Geometric Optics including reflection and refraction.
- Principles and applications of Nuclear Physics.
- Principles and applications of electricity and magnetism including simple circuits.

The fundamentals will be introduced through classroom discussions, lectures and exploratory labs. There is a strong emphasis on problem solving as well as application of the principles to real world examples.

**Course Information:**

**Frequency & Duration:** Daily for 42 minutes; 6 periods per week (includes 1 lab period)

**Text:** *Physics: Principles and Problems*, (Glencoe, 2002)
### Content: Scientific Methods

**Essential Question:** How do scientists use a universal system of measurement units to ensure international collaboration?

**Skills:**
- Utilize the International System of Units to evaluate the size and scale of various objects and measurements, including distance, time, mass,
- Explain how the behavior of matter and energy follow predictable patterns that are defined by laws.
- Analyze experimental data through graphical analysis.
- Express errors in data measurement
- Take measurements within the limits of the instrument precision (Significant Figures).

**Assessment:**
- Students will utilize the International System of Units to evaluate the size and scale of various objects and measurements, including distance, time, mass,
- Students will explain how the behavior of matter and energy follow predictable patterns that are defined by laws.
- Students will analyze experimental data through graphical analysis.
- Students will express errors in data measurement
- Students will take measurements within the limits of the instrument precision (Significant Figures).

**Resources / Activities:**
- Physics: Principles and Problems Ch 1-2 p. 2-41
- Measurements Lab
- Pendulum Lab

**Standards:**
3.2.10.B6. PATTERNS, SCALE MODELS, CONSTANCY/CHANGE: Explain how the behavior of matter and energy follow predictable patterns that are defined by laws.

**Vocabulary:**
- **International System of Units**: Based on the metric system, the standard system of units for science;
- **Scientific Law**: A statement based on repeated observations that describes an inherent property of the universe;
- **Scientific Theory**: A series of statements that provides the causal explanation for inherent properties of the universe. Provides explanations and predictions that can be tested
### Content: Laws of Motion and Translation

**Duration:** Sept./Oct. (6 weeks)

**Essential Question:**
- How can the motion of an object be described in a measurable and quantitative way?
- What causes the motion of an object to change?

**Skills:**
- Analyze the relationships among the net force, mass, acceleration using Newton’s Second Law of Motion.
- Use Newton’s Third Law to explain the forces as interactions between bodies.
- Use force and mass to explain the translational motion of objects.
- Use Newton’s Laws of Motion and to describe and predict the motion of objects including:
  - Projectile Motion
  - Translational Motion
  - Atwood Machines
  - Forces at Angles and Inclined Surfaces
- Compare and contrast motions of objects using forces.

**Assessment:**
- Students will use Newton’s Second Law of Motion to analyze the relationship between the net force on a body, its mass, and its acceleration.
- Students will use Newton’s Third Law to explain the forces as interactions between bodies.
- Students will use force and mass to explain the translational motion of objects.
- Students will use Newton’s Laws of Motion and to describe and predict the motion of objects including:
  - Projectile Motion
  - Translational Motion
  - Atwood Machines
  - Forces at Angles and Inclined Surfaces
- Students will compare and contrast motions of objects using forces.

**Resources / Activities:**
- *Physics: Principles and Problems* Ch 3-7 p. 42-173
- Labs:
  - Uniform Motion Lab
  - Accelerated Motion Lab
  - Free Fall Lab
  - Projectile Motion Lab
  - Force and Tension Accelerated Cart Lab

**Standards:**
- 3.2.10.B1. Analyze the relationships among the net forces acting on a body, the mass of the body, and the resulting acceleration using Newton’s Second Law of Motion.
  - Use Newton’s Third Law to explain forces as interactions between bodies.
- 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.
  - 3.2.12.B6. CONSTANCY/CHANGE Compare and contrast motions of objects using forces and conservation laws

**Vocabulary:**
- **Acceleration** - The rate of change of an object’s velocity; **Displacement** - The change in an object’s position; **Newton’s Laws of Motion** - 1) An object at rest will remain at rest, and object in motion will maintain its motion, unless acted on by a Net External Force, 2) The acceleration of an Object in proportional to the net external force on it, and inversely proportional to its mass, 3) When two objects interact, the forces of interaction are equal and opposite; **Velocity** - The rate of change of an object’s position
<table>
<thead>
<tr>
<th>Content: Simple Harmonic Motion</th>
<th>Duration: October (1 week)</th>
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</thead>
<tbody>
<tr>
<td>Essential Question: How can the motion of an object be described in a measurable and quantitative way? What causes the motion of an object to change?</td>
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</tr>
<tr>
<td>Skills:</td>
<td></td>
</tr>
<tr>
<td>- Differentiate among translational, simple harmonic in terms of position, velocity, and acceleration.</td>
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<tr>
<td>- Use force and mass to calculate simple harmonic motion of objects.</td>
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<tr>
<td>- Calculate simple harmonic motion of objects using conservation of energy and conservation of momentum.</td>
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<tr>
<td>- Compare and contrast motions of objects using forces and conservation laws.</td>
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<td></td>
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<td>- Students will differentiate among translational, simple harmonic motion in terms of position, velocity, and acceleration.</td>
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<tr>
<td>- Students will use force and mass to calculate the translational motion or simple harmonic motion of objects.</td>
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<td>- Students will Calculate the simple harmonic motion of objects using conservation of energy and conservation of momentum.</td>
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<tr>
<td>Resources / Activities:</td>
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<tr>
<td>- <em>Physics: Principles and Problems</em> Ch 6 p. 116-147</td>
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<tr>
<td>- Pendulum Lab Revisited I</td>
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<tr>
<td>- Mass/Spring SHM Lab</td>
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<tr>
<td>Vocabulary: Simple Harmonic Motion- A form of periodic motion where the restoring force is proportional to and opposite to the direction of the displacement of the object</td>
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<td>Comments:</td>
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</table>
## Content: Torque and Static Equilibrium

### Duration: November (2 weeks)

### Essential Question:

- How can the motion of an object be described in a measurable and quantitative way?
- What causes the motion of an object to change?

### Skills:

- Determine the magnitude and direction of a torque from a given force and lever arm.
- Analyze systems of static equilibrium in a two dimensional plane including:
  - Balanced single support systems (see-saw).
  - Balanced multiple support systems (Bridge/Scaffolding/Trusses)
- Utilize the principles of translational and rotational equilibrium to find an object’s center of mass.

### Assessment:

- Students will be able to determine the magnitude and direction of a torque from a given force and lever arm.
- Students will be able to analyze systems of static equilibrium in a two dimensional plane including:
  - Balanced single support systems (see-saw).
  - Balanced multiple support systems (Bridge/Scaffolding/Trusses)
- Students will be able to utilize the principles of translational and rotational equilibrium to find an object’s center of mass.

### Resources / Activities:

- *Physics: Principles and Problems* Ch 7 p. 148-173
- Labs:
  - Torque and Balance Lab
  - Truss Lab

### Standards:


### Vocabulary:

- **Static Equilibrium**: A condition which exists when the net force and net torque on an object equal zero;
- **Torque**: The ability of a force to cause an object to rotate about an axis

### Comments:
## Content: Rotational Motion

### Duration:
Nov./Dec. (3 weeks)

### Essential Question:

1. How can the motion of an object be described in a measurable and quantitative way?
2. What causes the motion of an object to change?

### Skills:

- Relate torque and rotational inertia to explain rotational motion.
- Analyze the principles of rotational motion to solve problems relating to angular momentum and torque.
- Differentiate among translational, simple harmonic and rotational motion in terms of position, velocity, and acceleration.
- Describe and analyze the rotational motion of objects using the conservation of energy and conservation of angular momentum.
- Compare and contrast motions of objects using forces and conservation laws.

### Assessment:

- Students will differentiate among translational, simple harmonic and rotational motion in terms of position, velocity, and acceleration.
- Students will analyze the principles of rotational motion to solve problems relating to angular momentum and torque.
- Students will relate torque and rotational inertia to explain rotational motion.
- Students will describe and analyze the rotational motion of objects using the conservation of energy and conservation of angular momentum.
- Students will compare and contrast motions of objects using forces and conservation laws.

### Resources / Activities:

- *Physics: Principles and Problems* Ch 7 p. 148-173
- Labs:
  - Centripetal Force Lab

### Standards:

- 3.2.P.B1. Relate torque and rotational inertia to explain rotational motion.
- 3.2.12.B1. Analyze the principles of rotational motion to solve problems relating to angular momentum and torque.
- 3.2.P.B2. Describe the rotational motion of objects using the conservation of energy and conservation of angular momentum. Explain how gravitational, electrical, and magnetic forces and torques give rise to rotational motion.

### Vocabulary:

- **Angular Momentum** - The product of an object’s Rotational Inertia and angular velocity; **Law of Conservation of Angular Momentum** - The Angular Momentum of an object remains constant when the net torque on the object is zero; **Rotational Inertia** - The mass property of a rigid body that measures its resistance to changing rotation.
**Content:** Universal Gravitation and Orbital Motion

**Duration:** December (1 week)

**Essential Question:**
- How can the motion of an object be described in a measurable and quantitative way?
- What causes the motion of an object to change?

**Skills:**
- Apply Newton’s Law of Universal Gravitation to the forces between two bodies.
- Explain how gravitational forces give rise to rotational motion.
- Explain how gravity is responsible for planetary orbits.
- Utilize Kepler’s Laws of Planetary Motion to predict the orbital period and velocity of planets, and both man-made and natural satellites.
- Use Newton’s Laws of Motion and to describe and predict the motion of objects ranging from atoms to the Galaxies.
- Compare and contrast motions of objects using forces and conservation laws.

**Assessment:**
- Students will be able to apply Newton’s Law of Universal Gravitation to the forces that exist between two bodies.
- Students explain how gravitational forces give rise to rotational motion.
- Students will explain how gravity is responsible for planetary orbits.
- Students will utilize Kepler’s Laws of Planetary Motion to predict the orbital period and velocity of planets, and both man-made and natural satellites.
- Students will use Newton’s Laws of Motion and Gravitation to describe and predict the motion of objects ranging from atoms to the Galaxies.
- Students will compare and contrast motions of objects using forces and conservation laws.

**Resources / Activities:** *Physics: Principles and Problems* Ch 8 p. 174-197

**Standards:**
- 3.3.10.B1. Explain how gravity is responsible for planetary orbits.

**Vocabulary:**
- **Kepler’s Laws of Planetary Motion:**
  - 1st Law: The path of an orbiting planet is an ellipse.
  - 2nd Law: The area swept by a planet in orbit is equal, for an equal amount of time.
  - 3rd Law: The square of the orbital period is proportional to the cube of the semi-major axis of a planet.

- **Law of Universal Gravitation:**
  The force of gravitational attraction between any two masses is proportional to the product of the two masses, and inversely proportional to the square of the distance between their centers of mass.

**Comments:**
<table>
<thead>
<tr>
<th>Content: Conservation of Momentum</th>
<th>Duration: January (2 weeks)</th>
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</table>

**Essential Question:**
- How can the motion of an object be described in a measurable and quantitative way?
- What causes the motion of an object to change?

**Skills:**
- Describe and analyze how interactions between an isolated system objects conserve momentum both one and two dimensional systems.
- Explain the translation of objects using conservation of energy and conservation of momentum.
- Demonstrate how the law of conservation of momentum provides an alternate approach to predict and describe the motion of objects.
- Compare and contrast motions of objects using forces and conservation laws.

**Assessment:**
- Students will describe and analyze how interactions between an isolated system objects conserve momentum in both one and two dimensional systems.
- Students will explain the translation motion of objects using conservation of energy and conservation of momentum.
- Students will demonstrate how the law of conservation of momentum provides an alternate approach to predict and describe the motion of objects.
- Students will compare and contrast motions of objects using forces and conservation laws.

**Resources / Activities:**
- *Physics: Principles and Problems* Ch 9 p. 198-221
- Collision Carts Lab
- Two Dimensional Collisions Lab

**Standards:**
- 3.2.10.B1. Describe how interactions between objects conserve momentum.

**Vocabulary:**
*Law of Conservation of Momentum*- When two isolated bodies interact, the vector sum of the momentum is a constant value; *Momentum*- The product of an object’s mass and velocity

**Comments:**
<table>
<thead>
<tr>
<th><strong>Content:</strong> Work, Energy, and Power</th>
<th><strong>Duration:</strong> Jan./ Feb. (4 weeks)</th>
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<tbody>
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<td>• Determine the work done and power delivered by various forces.</td>
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<tr>
<td>• Calculate the loss of energy in an open system.</td>
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<tr>
<td>• Demonstrate how the law of conservation of energy provides an alternate approach to predict and describe the motion of objects.</td>
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<tr>
<td>• Describe the law of conservation of energy and use it to analyze closed systems with and without friction.</td>
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<tr>
<td><strong>Resources / Activities:</strong></td>
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<tr>
<td><em>Physics: Principles and Problems</em> Ch 10-11 p. 222-273</td>
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<tr>
<td>Pendulum Lab Revisited II</td>
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<tr>
<td>Conservation of Energy (Ramp) Lab</td>
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<tr>
<td>Elastic Energy Projectile Lab</td>
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<tr>
<td><strong>Standards:</strong></td>
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<tr>
<td>3.2.10.B2. Explain how the overall energy flowing through a system remains constant. Describe the work-energy theorem. Explain the relationships between work and power.</td>
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<tr>
<td>3.2.P.B2. Explain the translation and simple harmonic motion of objects using conservation of energy and conservation of momentum.</td>
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<tr>
<td>3.2.12.B2. Explain how energy flowing through an open system can be lost. Demonstrate how the law of conservation of momentum and conservation of energy provide alternate approaches to predict and describe the motion of objects.</td>
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<tr>
<td>3.2.C.B3. Describe the law of conservation of energy.</td>
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<tr>
<td><strong>Vocabulary:</strong></td>
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<tr>
<td>Energy - ability of an object to do work; Law of Conservation of Energy - total energy in the universe is a constant. Energy cannot be created nor destroyed, but can be transferred or change forms; Power - rate at which work is done, or the rate at which energy is transferred; Work - product of force and displacement; Work Energy Theorem - net work done on an object will equal the object’s change in kinetic energy</td>
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<td><strong>Comments:</strong></td>
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</tbody>
</table>
**Content:** Thermodynamics

**Essential Question:** What are the fundamental rules that govern heat energy in the Universe?

**Skills:**
- Explain how energy flowing through an open system can be lost.
- Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached.
- Describe the law of conservation of energy.
- Analyze the factors that influence convection, conduction, and radiation between objects or regions that are at different temperatures.
- Analyze the process of convection, conduction, and radiation between objects or regions that are at different temperatures.
- Describe various thermodynamic processes including adiabatic, isochoric, and isothermal.
- Describe and apply the concept of latent heat.
- Calculate the amount of heat required for a phase change.
- Describe and analyze the relationship between potential energy, thermal energy, and work done on/by a system.

**Assessment:**
- Students will explain how energy flowing through an open system can be lost.
- Students will explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached.
- Students will describe the law of conservation of energy.
- Students will analyze the factors that influence convection, conduction, and radiation between objects or regions that are at different temperatures.
- Students will analyze the process of convection, conduction, and radiation between objects or regions that are at different temperatures.
- Students will describe various thermodynamic processes including adiabatic, isochoric, and isothermal.
- Students will describe and apply the concept of latent heat.
- Students will calculate the amount of heat required for a phase change.
- Students will describe and analyze the relationship between potential energy, thermal energy, and work done on/by a system.

**Resources / Activities:**
- *Physics: Principles and Problems* Ch 12-13 p. 272-325
- Labs: Specific Heat Lab
- Thermal Expansion Lab

**Standards:**
- 3.2.10.B3. Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached.
- 3.2.P.B3. Analyze the factors that influence convection, conduction, and radiation between objects or regions that are at different temperatures. Analyze the processes of convection, conduction, and radiation between objects or regions that are at different temperatures.
**Vocabulary:**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adiabatic</td>
<td>Thermodynamic process that occurs without the transfer of heat or matter between a system and its surroundings;</td>
</tr>
<tr>
<td>Isochoric</td>
<td>Thermodynamic process that occurs within a closed system while maintaining a constant volume;</td>
</tr>
<tr>
<td>Isothermal</td>
<td>Thermodynamic process that occurs while maintaining constant temperature;</td>
</tr>
<tr>
<td>Latent Heat</td>
<td>Heat released or absorbed by a substance during an isothermal thermodynamic process, such as a phase change;</td>
</tr>
<tr>
<td>Temperature</td>
<td>Measure of the average kinetic energy of the particles within a substance;</td>
</tr>
<tr>
<td>Thermal Energy (Heat)</td>
<td>Energy transferred between substances of different temperature, via conduction, convection, or radiation;</td>
</tr>
<tr>
<td>Thermal Equilibrium</td>
<td>State in which two bodies in contact have reached an identical temperature</td>
</tr>
</tbody>
</table>

**Comments:**

- **Academic Physics v. 2015 - 2016**
- **Vocabulary:**
  - Adiabatic: Thermodynamic process that occurs without the transfer of heat or matter between a system and its surroundings.
  - Isochoric: Thermodynamic process that occurs within a closed system while maintaining a constant volume.
  - Isothermal: Thermodynamic process that occurs while maintaining constant temperature.
  - Latent Heat: Heat released or absorbed by a substance during an isothermal thermodynamic process, such as a phase change.
  - Temperature: Measure of the average kinetic energy of the particles within a substance.
  - Thermal Energy (Heat): Energy transferred between substances of different temperature, via conduction, convection, or radiation.
  - Thermal Equilibrium: State in which two bodies in contact have reached an identical temperature.
### Content: Fluid Dynamics

#### Essential Question:
What behaviors do the fluid states of matter (liquid and gas) exhibit?

#### Skills:
- Explain the factors that affect the pressure in a fluid.
- Describe the behaviors of fluids using Pascal’s, Archimedes’ and Bernoulli’s Principles.
- Determine the apparent weight of an object in a fluid.
- Determine the fluid pressure at a given depth underwater.
- Analyze situations involving Archimedes principle.
- Analyze the factors that relate the pressure of flow rate of water through a pipe.

#### Assessment:
- Students will explain the factors that affect the pressure in a fluid.
- Students will describe the behaviors of fluids using Pascal’s, Archimedes’s and Bernoulli’s Principles.
- Students will determine the apparent weight of an object in a fluid.
- Students will determine the fluid pressure at a given depth underwater.
- Students will analyze situations involving Archimedes principle.
- Students will analyze the factors that relate the pressure of flow rate of water through a pipe.

#### Resources / Activities:
- *Physics: Principles and Problems* Ch 13 p. 298-313
- Archimedes’ Lab

#### Standards:
There are no applicable PA standards for this content.

### Vocabulary:
- **Archimedes’ Principle**: buoyant force on an object will be equal to the weight of the fluid it displaces; **Bernoulli’s Principle**: fluid pressure is inversely proportional to the speed of fluid flow; **Fluid**: states of matter that deform under shear stress, like liquids and gases; **Pascal’s Principle**: pressure applied in one area of an enclosed fluid is felt equally in all other areas; **Pressure**: force applied per unit area
**Content: Waves**

**Duration:** March/ April (3 weeks)

**Essential Question:**
How can waves be used to transmit information?

**Skills:**
- Understand and explain that waves transfer energy without transferring matter.
- Describe the causes of wave frequency, speed, and wave length.
- Compare and contrast transverse and longitudinal waves.
- Define wave behaviors including reflection, refraction, diffraction, interference, and polarization.
- Define and calculate luminous flux, illuminance and luminous intensity.
- Explain how light interacts with various types of matter including: Transparent, Translucent, and Opaque.
- Compare and contrast the wave nature of light and sound.
- Describe the components of the electromagnetic spectrum.
- Explain how waves carry information from remote sources that can be detected and interpreted.
- Research how principles of wave transmission are used in a wide range of technologies and research those technologies that incorporate the principles of wave transmission.

**Assessment:**
- Students will understand and explain that waves transfer energy without transferring matter.
- Students will describe the causes of wave frequency, speed, and wave length.
- Define and calculate luminous flux, illuminance and luminous intensity.
- Students will explain how light interacts with various types of matter including: Transparent, Translucent, and Opaque.
- Students will compare and contrast transverse and longitudinal waves.
- Students define wave behaviors including reflection, refraction, diffraction, interference, and polarization.
- Students will compare and contrast the wave nature of light and sound.
- Students will describe the components of the electromagnetic spectrum.
- Students will explain how waves carry information from remote sources that can be detected and interpreted.
- Students will research how principles of wave transmission are used in a wide range of technologies and research those technologies that incorporate the principles of wave transmission.

**Resources / Activities:**
- *Physics: Principles and Problems* Ch 14-19 p. 326-459
- Resonance/Speed of Sound Lab
- Speed of Light (S’mores)
- Snell’s Law

**Standards:**
3.2.10.B5. Understand that waves transfer energy without transferring matter. Compare and contrast the wave nature of light and sound. Describe the components of the electromagnetic spectrum. Describe the difference between sound and light waves.

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.

3.2.12.B5. Research how principles of wave transmissions are used in a wide range of technologies. Research technologies that incorporate principles of wave transmission.
Vocabulary:

**Electromagnetic Wave** - transverse wave consisting of oscillating electric and magnetic fields at right angles to each other (light wave); **Reflection** - returning of a wave when it encounters a boundary; **Refraction** - change in the direction of waves crossing the boundary between two different media; **Sound** - longitudinal density wave created by a vibrating source; **Wave** - disturbance or oscillation of matter or electromagnetic fields that travels through matter or space with an accompanying transfer of energy.
<table>
<thead>
<tr>
<th><strong>Content:</strong> Geometric Optics</th>
<th><strong>Duration:</strong> April (2 weeks)</th>
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<tbody>
<tr>
<td><strong>Essential Question:</strong></td>
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<tr>
<td>How can light be modeled as a stream of particles?</td>
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<tr>
<td>How can we utilize and manipulate light?</td>
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<table>
<thead>
<tr>
<th><strong>Skills:</strong></th>
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<tbody>
<tr>
<td>- Explain the differences between reflection and refraction.</td>
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<tr>
<td>- Define Diffuse and Regular Reflection.</td>
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<tr>
<td>- Explain the index of refraction and use it to calculate the speed of light in various mediums.</td>
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<tr>
<td>- Explain total internal reflection and the related critical angle.</td>
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<tr>
<td>- Predict the refraction angle of light using Snell’s Law.</td>
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<tr>
<td>- Explain the difference between real and virtual images.</td>
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<tr>
<td>- Use the principles of reflection and refraction to predict and describe the nature of reflected and refracted images from concave and convex mirrors, and converging and diverging lenses.</td>
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<tr>
<td>- Use Light Ray Diagrams to predict the nature of reflected and refracted images.</td>
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<th><strong>Assessment:</strong></th>
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<tr>
<td>- Students will explain the differences between reflection and refraction.</td>
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<tr>
<td>- Students will define Diffuse and Specular Reflection.</td>
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<td>- Students will explain the index of refraction and use it to calculate the speed of light in various mediums.</td>
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<td>- Students will explain total internal reflection and the related critical angle.</td>
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<td>- Students will predict the refraction angle of light using Snell’s Law.</td>
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<tr>
<td>- Students will explain the difference between real and virtual images.</td>
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<tr>
<td>- Students will use the principles of reflection and refraction to predict and describe the nature of reflected and refracted images from concave and convex mirrors, and converging and diverging lenses.</td>
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<tr>
<td>- Students will use Light Ray Diagrams to predict the nature of reflected and refracted images.</td>
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<tr>
<th><strong>Resources / Activities:</strong></th>
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<tbody>
<tr>
<td><em>Physics: Principles and Problems</em> Ch 14-19 p. 326-459</td>
</tr>
<tr>
<td>Snell’s Law</td>
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<tr>
<td>Concave Mirror Lab</td>
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<td>Converging Lens Lab</td>
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<tr>
<th><strong>Standards:</strong></th>
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<tr>
<td>3.2.10.B5</td>
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<td>3.2.P .B5</td>
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<tr>
<td>3.2.12.B5</td>
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<tr>
<td>Vocabulary:</td>
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<tr>
<td><strong>Critical Angle</strong>- incident angle unique to a substance that causes the refracted ray to lie along the boundary of the substance; <strong>Diffuse Reflection</strong>- reflection off a rough surface that randomly scatters light rays; <strong>Index of Refraction</strong>- ratio of the speed of light in a vacuum to the speed in a material; <strong>Light Ray Diagram</strong>- diagram technique that shows the convergence/divergence of light rays to predict the qualities of an image; <strong>Real Image</strong>- optical image formed when light rays converge and pass through the image, producing an image that can be projected onto a screen; <strong>Reflection</strong>- occurs when light is incident on the boundary to a less optically dense medium at an angle so large there is no refracted ray; <strong>Regular Reflection</strong>- reflection off a smooth surface that produces parallel light rays, such as a mirror; <strong>Snell’s Law</strong>- ratio of the sine of the angle of incidence to the sign of the angle of refraction is constant; <strong>Total Internal Virtual Image</strong>- point from which light rays appear to diverge without actually doing so.</td>
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<tr>
<td><strong>Content:</strong> Modern Physics (Quantum/Nuclear)</td>
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<tr>
<td><strong>Essential Question:</strong> How is nuclear matter held together? How can the nucleus of an atom change or decay?</td>
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<tr>
<td><strong>Skills:</strong></td>
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<tr>
<td>• Identify the structure and forces within an atomic nucleus.</td>
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<tr>
<td>• Calculate the binding energy of various nuclei as well as various decay modes.</td>
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<tr>
<td>• Utilize the concept of half-life to determine radioactivity, isotope percentages and time of decay.</td>
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<td><strong>Assessment:</strong></td>
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<tr>
<td>• Students will identify the structure and forces within an atomic nucleus.</td>
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<tr>
<td>• Students will calculate the binding energy of various nuclei as well as various decay modes.</td>
</tr>
<tr>
<td>• Students will utilize the concept of half-life to calculate radioactivity, the number of atoms decayed, and time of decay.</td>
</tr>
<tr>
<td><strong>Resources / Activities:</strong></td>
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<tr>
<td><em>Physics: Principles and Problems</em> Ch 27-28 p. 624-667 and Ch 30-31 p. 690-735</td>
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<tr>
<td>Properties of Radioactivity Lab</td>
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<tr>
<td>Radioactivity Half-Life Lab</td>
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<tr>
<td><strong>Standards:</strong> 3.2.C.A3 Identify the three main types of radioactive decay and compare their properties. Describe the process of radioactive decay by using nuclear equations and explain the concepts of half-life for an isotope. Compare and contrast nuclear fission and nuclear fusion.</td>
</tr>
<tr>
<td><strong>Vocabulary:</strong></td>
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<tr>
<td><strong>Binding Energy</strong> - energy required to split from a nucleus its component parts or nucleons; <strong>Half Life</strong> - amount of time for half of a quantity of atoms to decay; <strong>Nucleus</strong> - positively charged central core of an atom consisting of protons and neutrons, and possessing nearly all of the atom’s mass; <strong>Radioactive Decay</strong> - spontaneous breakdown of a nucleus resulting in the release of energy and matter, often changing the identity of the atom</td>
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<td><strong>Comments:</strong></td>
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Content: Electric and Magnetic Forces, and Electric Current

Duration: May/June (4 weeks)

Essential Question:
How are Electricity and Magnetism linked as a single force?
What are the properties that govern the function of various circuits?

Skills:
• Describe the relationship between electricity and magnetism as two aspects of a single electromagnetic force.
• Explain how stationary and moving particles result in electricity and magnetism.
• Explain how electrical induction is applied in technology.
• Describe conceptually the attractive and repulsive forces between objects relative to their charges and the distance between them.
• Use Coulomb’s Law to analyze the forces in a charge distribution.
• Calculate the Electric field due to a charge distribution.
• Describe quantitatively the relationships between voltage, current, and resistance to electrical energy and power.
• Develop a relationship between the length and gauge of a wire and its resistance.
• Develop qualitative and quantitative understanding of current, voltage, resistance, and the connections among them.
• Analyze series and parallel circuits and as well as complex circuits requiring the Application of Kirchoff’s Laws.

Assessment:
• Students will describe the relationship between electricity and magnetism as two aspects of a single electromagnetic force.
• Students will explain how stationary and moving particles result in electricity and magnetism.
• Students will explain how electrical induction is applied in technology.
• Students will describe conceptually the attractive and repulsive forces between objects relative to their charges and the distance between them.
• Students will describe quantitatively the relationships between voltage, current, and resistance to electrical energy and power.
• Students will develop qualitative and quantitative understanding of current, voltage, resistance, and the connections among them.

Resources / Activities:

Physics: Principles and Problems Ch 20-26 p. 460-623
Demos:
Electrostatics
Magnetism

Labs:
Ohm’s Law Lab
Series and Parallel Connection Lab
RC Circuit Lab
Resistivity of Play Doh Lab
Resistance of Wire Coils Lab

Standards:
3.2.12.B4. Describe conceptually the attractive and repulsive forces between objects relative to their charges and the distance between them.
3.2.10.B4. Describe the relationship between electricity and magnetism as two aspects of a single electromagnetic force.
3.2.P.B4. Explain how stationary and moving particles result in electricity and magnetism.
3.2.10.B4. Describe quantitatively the relationships between voltage, current, and resistance to electrical energy and power.
3.2.P.B4. Develop qualitative and quantitative understanding of current, voltage, resistance, and the
connections among them.

Explain how electrical induction is applied in technology.

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<td><strong>Current</strong> - time rate of charge flow through a circuit; <strong>Electromagnetic Field</strong> - physical field produced by electrically charged objects, in which other charged objects would feel a force or torque; <strong>Electromagnetic Force</strong> - one of the four fundamental forces of nature, describing the interaction between charged particles; <strong>Kirchhoff's Junction Rule</strong> - total current entering a junction must equal the current leaving the junction; <strong>Kirchhoff's Loop Rule</strong> - total potential difference around a closed conducting loop must be zero; <strong>Parallel Circuit</strong> - circuit in which all elements are wired with their own conducting path to the battery; <strong>Power</strong> - time rate of energy dissipation/deliverance of a circuit element; <strong>Resistance</strong> - opposition to charge flow, the number of volts required per Ampere of current; <strong>Resistivity</strong> - strength of a material’s ability to oppose the flow of electric charges; <strong>Series Circuit</strong> - circuit in which all elements are wired in the same conducting path to the battery; <strong>Voltage</strong> - electric potential difference between two points in a circuit</td>
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Comments: