Physics

2020 New Jersey Student Learning Standards- Science

Performance Expectations

HS-PS1-3	**Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.**
HS-PS1-8	**Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.**
HS-PS2-1	**Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.**
HS-PS2-2	**Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.**
HS-PS2-3	**Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.**
HS-PS2-4	**Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.** [
HS-PS2-5	**Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.**
HS-PS2-6	**Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.**
HS-PS3-1	**Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.**
HS-PS3-2	**Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).**
HS-PS3-3	**Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.**
HS-PS3-4	**Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).**

HS-PS3-5	**Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.**
HS-PS4-1	**Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.**
HS-PS4-2	**Evaluate questions about the advantages of using a digital transmission and storage of information.**
HS-PS4-3	**Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.**
HS-PS4-4	**Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.**
HS-PS4-5	**Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.**
HS-ESS1-1	**Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.**
HS-ESS1-2	**Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.**
HS-ESS1-3	**Communicate scientific ideas about the way stars, over their life cycle, produce elements.**
HS-ESS1-4	**Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.**
HS-ESS1-5	**Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.**
HS-ESS1-6	**Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.**
HS-ESS2-1	**Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.**
HS-ESS2-3	**Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.**
HS-ESS3-2	**Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.**
HS-ESS3-3	**Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.**

HS-ETS1-1	**Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.**
HS-ETS1-2	**Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.**
HS-ETS1-3	**Evaluate a solution to a complex real-world problembased on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.**
HS-ETS1-4	**Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.**

Science and Engineering Practices

- Practice 1: Asking Questions and Defining Problems
- Practice 2: Developing and Using Models
- Practice 3: Planning and Carrying Out Information
- Practice 4: Analyzing and Interpreting Data
- Practice 5: Using Mathematics and Computational Thinking
- Practice 6: Constructing Explanations and Designing Solutions
- Practice 7: Engaging in Argument from Evidence
- Practice 8: Obtaining, Evaluating, and Communicating Information

Cross Cutting Concepts

- Patterns
- Cause and Effect
- Scale, Proportion and Quantity
- Systems and System Models
- Energy and Matter
- Structure and Functions
- Stability and Change

Disciplinary Core Ideas

- PS1.A Structure and Properties of Matter
- PS1.C Nuclear Processes
- PS2.A Forces and Motion
- PS2.B Types of Interactions
- PS3.A Definitions of Energy
- PS3.B Conservation of Energy
- PS3.C Relationship between Energy and Forces
- PS3.D Energy in Chemical Processes
- PS4.A Wave Properties
- PS4.B Electromagnetic Radiation
- PS4.C Information and Technologies Instrumentation
- ESS1.A The Universe and Its Stars
- ESS1.B Earth and The Solar System
- ESS1.C The History of Planet Earth
- ESS2.A Earth Materials and Systems
- ESS2.B Plate Tectonics and Large-Scale System Interactions
- ESS3.A Natural Resources
- ESS3.C Human Impacts on Earth Systems
- ETS1.A Defining and Delimiting Engineering Problems
- ETS1.B Developing Possible Solutions
- ETS1.C Optimizing the Design Solution

Unit 1: Measurements and Kinematics

Overview:

Physics is based upon observation, measurement, and interpretation of the physical world. This unit will introduce the SI system and scientific notation, how to express and convert measurements and the concepts of uncertainty, precision, and accuracy. Graphical presentation of data will be discussed. The concepts used to describe motion- position, velocity, and acceleration will be discussed. Students will explore one dimensional motion and two-dimensional motion.

STAGE 1
Desired Results

Essential Questions…

- What are base units?
- How are prefixes used to modify base units?

- What is the main reason for using scientific notation?
- How do scientists share their findings with the scientific community?
- How do we describe the motion of objects?
- How do we create mathematical models that represent the motion of objects?
- How do we use mathematical model to predict the motion of objects?
- How are speed and velocity different?
- How do you analyze the relationship of velocity to acceleration?
- How can vectors be represented?
- What are the applications of vector?
- What is projectile motion?
- What causes projectiles to move in its trajectory?

Enduring Understanding…

Mathematics is a tool used to model objects, events, and relationships in the natural and designed world. The same basic principles and models can describe the motion of all objects. Motion in two dimensions can be analyzed easier when it is divided into two components.

Students will be able to...

- Use SI units in the correct format for all required measurements, recognize metric prefix meanings, and convert to base units.
- Describe the motion of an object in terms of a reference frame.
- Collect data from moving objects and analyze information in the form of graphs and tables.
- Find patterns in data and use these patterns to develop models and explanations.
- Interpret displacement, velocity, and acceleration versus time graphs.
- Interpret the motion of an object moving with constant acceleration using a position - time graph as well as a velocity - time graph.
- Create mathematical models for the relationship between constant acceleration, initial and final velocities, time, and displacement.
- Algebraically manipulate mathematical models of constant acceleration to solve for variables.

Students will know...

Assessment Topic #1 Measurements

Key Terms/Vocabulary:

- SI Units and quantities

- Basic math for physics

Main Ideas/Concepts:

- Using SI units in the correct format for all required measurements, final answers to calculations, and presentation of raw and processed data.
- Standard prefixes are used to designate common multiples in powers of ten.
- Scientific notation is used to save time and effort when writing out very large and very small numbers.
- How to apply significant figures when making measurements and evaluating arithmetic expressions.

Possible Misunderstandings:

- Always start at the end of the measuring device when measuring a distance.
- If a measurement is made to many significant figures then it must be more accurate.
- Mass is a quantity that you get by weighing an object.

Assessment Topic #2 Displacement, Velocity, and Acceleration

Key Terms/Vocabulary:

- Distance and displacement
- Speed and velocity
- Acceleration
- Graphs describing motion
- Equations of motion for uniform acceleration
- Free Fall

Main Ideas/Concepts:

- Displacement of an object is the change in its position and distance is the total length traveled.
- Velocity gives the rate of motion and its direction, whereas speed gives only the reate of motion.
- The slope of a straight line on a position-time graph equals the average velocity of the motion during that time period.
- Acceleration occurs when there is a change in speed, a change in direction, or a change in both speed and direction.
- Constant acceleration produces a parabolic position – time graph.
- When the acceleration is constant, the equations of motion can be used to describe motion.
- The motion of an object can be treated as free fall whenever the effects of air resistance are small enough to ignore.

Possible Misunderstandings:

- If the velocity is constant, then acceleration is also constant.
- Acceleration always means that an object is speeding up.
- If speed of the object is constant, then acceleration is zero.
- Acceleration always occurs in the same direction as an object is moving.
- If the acceleration is positive then the object speeds up, and if the acceleration is negative then the object is slowing down.
- Acceleration is the same as velocity.

Assessment Topic #3 Projectile Motion

Key Terms/Vocabulary:

- Scalars and Vectors
- Resultant
- Components
- Projectile Motion

Main Ideas/Concepts:

- A vector is a quantity that is specified by both a magnitude and a direction.
- The resultant of two vectors can be determined from a vector diagram drawn to scale.
- To resolve a vector means to find its components.
- An ideal projectile follows a parabolic path regardless of how it is launched.
- When gravity is the only force acting on a projectile near Earth, the horizontal component of its velocity does not change.

Possible Misunderstandings:

- A projectile has zero velocity at its maximum height, or that it's acceleration is zero at maximum height.
- Heavier objects fall faster than light ones.

STAGE 2
Evidence of Learning

Formative Activities, Tasks, or Projects:

Assessment Topic #1 Measurements

- Measurement labs using a variety of measuring devices.
- Class discussions
- Quiz

Assessment Topic #2 Displacement, Velocity, and Acceleration

- Investigation Assessment
- Phet Simulation - Virtual Lab performance based assessment
- CER – Position versus Time graphs;
- Free fall acceleration – Vernier lab-quest lab analysis
- Quiz – Displacement and velocity
- Quiz - Acceleration

Assessment Topic #3 Projectile Motion

- Phet Simulation: Vector addition
- Lab report – Model Projectile motion
- Phet Simulation – Projectile Motion
- CER- Horizontal motion of falling objects

Summative Activities, Tasks, or Projects:

End of unit Assessment
Catapult project

STAGE 3
Learning Plan

Assessment Topics and Lesson Themes:

Assessment Topic #1: Measurements
Lesson Themes 1.1 Fundamental and Derived Units

- Explain the difference between *dimension* and *unit*. Ask students to generate examples that include both a dimension and a unit.
- Demonstration to show that standard units of measurement are based on arbitrary convention.
- Display various measuring instruments. Ask students to describe what instrument they would use to measure properties of objects found in the classroom. Let students walk around the exhibit and take notes about the different methods and units of measure.

Lesson Themes 1.2 Significant Figures, Scientific notation and metric multipliers

- Activity to clarify the meaning of significant figures.
- Explore the use of prefixes for powers of 10 with metric units.

Assessment Topic #2: Displacement, Velocity, and Acceleration

Lesson Themes 2.1 – Distance and Displacement

- Let students collect their own data in a data table by rolling a toy car down a ramp of increasing height. Let students create a graph of their data. Do "Moving Man" simulation to understand motion concepts.

Lesson Themes 2.2 – Speed and Velocity

- Let students collect their own data in a data table by rolling a toy car down a ramp of increasing height. Let students create a graph of their data. Do "Moving Man" simulation to understand motion concepts.

Lesson Themes 2.3 – Acceleration

- Let students collect their own data in a data table by rolling a toy car down a ramp of increasing height. Let students create a graph of their data. Do "Moving Man" simulation to understand motion concepts.

- Vernier Picket fence Lab

Assessment Topic #3: Projectile Motion

Lesson Themes 3.1 – Scalars and Vectors
- Students complete a lab activity in which students determine distances and displacements by combining vector components.
- Phet Simulation: Vector addition

Lesson Themes 3.2 - Projectile Motion
- Phet Simulation "Projectile Motion"
- Lab: Determine the initial velocity of a projectile

Unit Specific Accommodations and Modifications

Gifted and Talent Accommodations and Modifications:

- Allow for further independent research on topics of interest related to the unit of study
- Advanced leveled readers and sources
- Increase the level of complexity
- Decrease scaffolding
- Variety of finished products
- Allow for greater independence
- Learning stations, interest groups
- Varied texts and supplementary materials
- Use of technology
- Flexibility in assignments
- Varied questioning strategies
- Encourage research
- Strategy and flexible groups based on formative assessment or student choice
- Acceleration within a unit of study
- Exposure to more advanced or complex concepts, abstractions, and materials
- Encourage students to move through content areas at their own pace
- After mastery of a unit, provide students with more advanced learning activities, not more of the same activity
- Present information using a thematic, broad-based, and integrative content, rather than just single-subject areas

Special Education, and At-Risk Accommodations and Modifications:

- Focus on concept not details
- More visual prompts
- Leveled readers and teacher annotated sources
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required

- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

English Language Learners:

- Focus on concept not details
- More visual prompts
- Leveled readers and teacher annotated sources
- Guided notes with highlighted words and concepts
- Use of Merriam-Webster’s ELL dictionary
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
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- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials

- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

Unit Specific Interdisciplinary Connections / Materials

- Students studying other science subject will be able to use these skills across all subjects. This topic can be integrated into any topic taught at the start of the course and is important to all topics.
- Mathematics: Graph linear and quadratic functions, solve kinematic equations.
- Language Arts: For an activity in this unit write a lab report
- Social studies: Investigate the life of Isaac Newton and other significant events that occurred or people who made contributions to science

Additional Materials

Digital Tools/Resources:

Savvas Experience Physics

Internet resources:

Khan Academy: https://www.khanacademy.org

Physicsclassroom.com: http://www.physicsclassroom.com/

Phet Simulations: http://phet.colorado.edu/en/simulation/

YouTube videos

http://hyperphysics.phy-astr.gsu.edu/hbase/units.html

Unit 2: Dynamics

Overview:

Newton's laws of motion form the foundation of the branch of physics known as classical mechanics. Each law of motion that Newton developed has significant mathematical and physical interpretations that are needed to understand the motion of objects in our universe. Essentially, these laws define the means by which motion changes, specifically the way in which those changes in motion are related to force and mass.

STAGE 1
Desired Results

Essential Questions…

- What causes an object to change its motion?
- How are Newton's laws of motion applied to describe the motion of an object or system?
- How can the forces exerted on an object or system be represented physically and mathematically?
- What are different kinds of forces?
- What is weight?
- What is the difference between mass and weight?
- How do you determine the net force on an object?
- What are the types of friction?
- Why does friction occur?
- How can friction be both harmful and helpful?

Enduring Understanding…

External, unbalanced forces are required to change a system's motion.

An object that exerts a force on a second object will have an equal and opposite force exerted on itself by the second object.

Students will be able to...

- Draw force and motion diagrams to represent a given scenario.
- Apply Newton's laws of motion to describe phenomenon verbally and mathematically.
- Algebraically manipulate mathematical model of Newton's second law of motion to predict unknown variables.
- Differentiate between 'mass' and 'weight'.
- Explain Hooke's law.
- Identify situations of equilibrium.
- Identify different types of forces.
- Identify and describe action and reaction forces.
- State Newton's third law of motion.

Students will know...

Assessment Topic #1: Force, Mass, and Aceeleration

Key Terms/Vocabulary:

- Inertia
- Newton's first law of motion
- Newton's second law of motion
- Mass and weight
- Net force
- Equilibrium
- Newton's third law of motion
- Free-body diagram

Main Ideas/Concepts:

- There is always a force involved when something starts moving or changes its speed or direction of motion. A greater force can make an object move faster and farther.
- The motion of an object changes only when a net force is applied
- During interactions every action force is countered by an equal and opposite reaction force.
- Mass is a direct measurement of inertia, resistance to acceleration
- The weight of an object is the gravitational force acting on it.
- An object is in equilibrium when it is at rest, with zero net force acting on it.
- The weight of an object is equal to its mass times the acceleration due to gravity.
- Interacting things exert forces on each other.

Possible Misunderstandings:

- If an object is at rest, no forces are acting on the object.
- The velocity of an object must be in the same direction as the net force on the object.
- Forces are required for motion with constant velocity.
- Acceleration always occurs in the same direction as an object is moving.
- Acceleration always means that an object is speeding up.

Assessment Topic #2 : Types of Forces

Key Terms/Vocabulary:

- Friction
- Static and Kinetic friction
- Coefficient of friction
- Tension
- Hooke’s Law

Main Ideas/Concepts:

- Friction is a force that acts to slow or stop the motion of objects.
- Friction and fluid drag forces tend to slow or prevent the motion of objects.
- The force of kinetic friction is proportional to the normal force.
- Kinetic friction does not depend on the speed or surface area of objects that are sliding past one another.
- Static friction exerts a force whose magnitude can vary from zero to a maximum.
- The conditions for equilibrium can be used to determine the forces acting on an object.
- Tension is the force exerted by a string, rope, or wire that is pulled tight.
- The force to stretch or compress a spring is given by Hooke's Law.

Possible Misunderstandings:

- The normal force on an object always equals the weight of the object.
- Equilibrium means that all the forces on an object are equal.

STAGE 2
Evidence of Learning

Formative Activities, Tasks, or Projects:

Assessment Topic #1: Force, Mass, and Aceeleration

- Describe different physical situations and ask students which Newton's Law the situation demonstrates.
- Phet Simulation lab.
- Newton's second law lab report
- Online quiz
- Force Table lab report
- Investigative phenomenon CER

Assessment Topic #2 : Types of Forces

- Discuss different types of forces and list situations where each type of force occurs.
- Static and Kinetic Friction lab report- Examine the force of friction on an object and determine the coefficients of static and kinetic friction acting between a wooden block and a tabletop
- Hooke's Law lab analysis
- Research the design features of skyscrapers that were recently built-in high-risk earthquake zones. Then design and draw a tall building showing the earthquake mitigating features they chose to incorporate. Explain why they picked those features.
- Phet simulation – Masses and Springs – data analysis

Summative Activities, Tasks, or Projects:

Unit test; Culminating Projects at the end of the Unit.

STAGE 3
Learning Plan

Assessment Topics and Lesson Themes:

Assessment Topic #1: Force, Mass, and Aceeleration

Lesson Themes 1.1

- Assemble a cart and hanging mass system to collect measurements to determine the relationship between force and acceleration of the system.
- Use Phet Simulation – Forces and motion- to explore the relationship between force, mass and acceleration.
- CER – Write a question about the changes in motion that can be observed when two students in rolling chairs push off from each other.

Lesson Themes 1.2

- Use a toy car and a book to model a car colliding with a brick wall. Observe the motion of the car before and after the crash. Identify the changes in motion and identify the forces that caused them.
- Draw free body diagrams for different situations.

Assessment Topic #2: Types of Forces

Lesson Themes 2.1

- Examine the force of friction on an object and determine the coefficients of static and kinetic friction acting between a wooden block and a tabletop.

Lesson Themes 2.2

- Design an experimental procedure to investigate the physical factors that affect the force of friction between two objects and use physical models to quantify friction between different surfaces.
- Phet Simulation – Masses and Springs- to explore equilibrium conditions and to determine spring constant.

Unit Specific Accommodations and Modifications

Gifted and Talent Accommodations and Modifications:

- Allow for further independent research on topics of interest related to the unit of study
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- Increase the level of complexity
- Decrease scaffolding
- Variety of finished products
- Allow for greater independence
- Learning stations, interest groups
- Varied texts and supplementary materials
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- Flexibility in assignments
- Varied questioning strategies
- Encourage research
- Strategy and flexible groups based on formative assessment or student choice
- Acceleration within a unit of study

- Exposure to more advanced or complex concepts, abstractions, and materials
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Special Education, and At-Risk Accommodations and Modifications:

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- More visual prompts
- Leveled readers and teacher annotated sources
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
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- Use technology, if available and appropriate
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- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
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- Differentiated checklists and rubrics, if available and appropriate

English Language Learners:

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- Guided notes with highlighted words and concepts

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- Timelines and graphic organizers
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- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

Unit Specific Interdisciplinary Connections / Materials

- Mathematics: Quadratic functions and kinematic equations; Components of vectors.
- Students studying other science subject will be able to use these skills across all subjects.
- Language Arts: For an activity in this unit write a lab report.
- Social Studies: Discuss different designs created over the centuries to launch projectiles.

Additional Materials

Digital Tools/Resources:

Savvas Experience Physics

Internet resources:

Khan Academy: https://www.khanacademy.org

Physicsclassroom.com: http://www.physicsclassroom.com/

Phet Simulations: http://phet.colorado.edu/en/simulation/

YouTube videos

http://hyperphysics.phy-astr.gsu.edu/

Unit 3: Circular Motion and Gravitation

Overview:

Gravity is one of the most easily observed forces in the universe. This unit introduces the concept of gravitational force. Newton's theory was the first to explain the motion of the objects in the heaven. This section also introduces tangential speed, centripetal acceleration, and centripetal force. The Newtonian idea of gravitational force acting between two spherical bodies, plus the laws of mechanics, creates a model that can be used to calculate the motion of planets.

STAGE 1
Desired Results

Essential Questions…

- What are some practical applications and consequences of gravity?
- How does the moon shape our coastline?
- What underlying forces explain the variety of interactions observed?
- What are Kepler's Laws of Planetary Motion?
- How is circular motion produced?

Enduring Understanding…

Forces at a distance are explained by fields that can transfer energy and that can be described in terms of the arrangement and properties of the interacting objects and the distance between them. Objects moving in circular paths experience constant acceleration. Centripetal forces hold objects in circular paths. Gravitational forces accelerate objects into orbital paths.

Students will be able to...

- Explain how Newton's Law of Universal Gravitation accounts for various phenomena, including satellite and planetary orbits and falling objects.
- Apply Newton's Law of Gravitation to solve problems.
- Solve problems involving centripetal acceleration.
- Solve problems involving centripetal force.

- Give examples of centripetal force.
- Show an understanding of the centripetal acceleration of objects in circular motion and apply Newton's laws to such motion.
- Calculate the magnitude and identify the direction of the centripetal force acting on an object.
- Describe how factors such as mass and distance affect the force of gravity through the universe.
- Apply Kepler's laws to the motion of celestial objects and / or satellites.

Students will know...

Assessment Topic #1 Universal Gravitation

Key Terms/Vocabulary:

- Newton's Law of Universal Gravitation
- Inverse square law
- Gravitational Field
- Applications of Gravity

Main Ideas/Concepts:

- Gravitational interactions are very weak compared to other interactions and are difficult to observe unless one of the objects is extremely massive (e.g., the sun, planets, moons).
- Everything pulls on everything else with a force that depends upon the masses of the objects and the distance between their centers of mass.
- The force of gravity decreases as the inverse square of the distance.
- Greater gravitational field strengths result in larger gravitational forces on masses placed in the field.
- When air resistance is negligible, all falling objects on Earth accelerate at the same rate.
- Tides result from the variation of the gravitational force from one side of an astronomical object to the other side.

Possible Misunderstandings:

- The force that acts on apple is not the same as the force that acts on the Moon.
- The gravitational force is the same on all falling bodies.
- Weightlessness means there is no gravity.
- There are no gravitational forces in space.

Assessment Topic #2 Uniform Circular motion

Key Terms/Vocabulary:

- Circular Motion
- Tangential speed
- Centripetal acceleration

- Centripetal force

Main Ideas/Concepts:

- An inward radial force is required to produce constant circular motion.
- The center directed acceleration of an object in circular motion is the centripetal acceleration.
- The centripetal force is always perpendicular to the tangential velocity of the object in circular motion.

Possible Misunderstandings:

- Circular motion does not require a force.
- Centrifugal forces are real.
- An object moving in circle with constant speed has no acceleration.
- An object moving in a circle will continue in circular motion when released.
- An object is circular motion will fly out in a curve when released

Assessment Topic #3 Kepler's Laws

Key Terms/Vocabulary:

- Period
- Planetary Motion
- Orbit
- Ellipse
- Kepler's Laws

Main Ideas/Concepts:

- Planets follow elliptical orbits, with the Sun at one focus of the ellipse.
- As a planet moves in its orbit, it sweeps out an equal amount of area in an equal amount of time.
- The period of a planet increases as its distance from the Sun raised to the 3/2 power.
- The period of an orbiting planet or moon depends on the mass being orbited.

Possible Misunderstandings:

- Planetary orbits are circles.
- The speed of a planet in orbit never changes.
- All the planets move in their orbits with the same speed.
- The orbits of the planets lie precisely in the same plane.

STAGE 2
Evidence of Learning

Formative Activities, Tasks, or Projects:

Assessment Topic #1 Universal Gravitation

- Investigative phenomenon CER
- Phet: Gravity -Force Lab data analysis
- Quiz

Assessment Topic #2 Uniform Circular motion

- Phet: Planets and orbits Simulation
- Lab: Uniform circular motion
- Quiz

Assessment Topic #3 Kepler's Laws
- Inquiry Lab worksheet
- Phet: Gravity and orbits lab
- Quiz

Summative Activities, Tasks, or Projects:
Culminating Projects at the end of the Unit; Unit test

STAGE 3
Learning Plan

Assessment Topics and Lesson Themes:

Assessment Topic #1: Newton's Law of Universal Gravitation
Lesson Themes 1.1
- Solve problems using the equation for universal gravitation (e.g., determine the net force on a mass at a point between Earth and another stellar object, determine why the gravitational force between two people is negligible, determine the value for g from the equation and Newton's Second Law).
- Use the Phet Gravity Force Lab to investigate the relationship between masses of objects, distance between them and gravitational force. Verify the force law for gravitational interaction using values from the simulation

Lesson Themes 1.2
- Describe how changing the distance between two objects or the mass of the objects affects the gravitational force between them.
- Use measurements to determine the universal gravitational constant.

Assessment Topic #2: Uniform Circular Motion

Lesson Themes 2.1 Period and Centripetal acceleration
- Investigate the relationship between the speed of an object undergoing uniform circular motion and the centripetal force on the object.

Lesson Themes 2.2 Centripetal Force
- Inquiry lab- Model the orbital motion of planets.

Assessment Topic #3: Kepler's Laws

Lesson Themes 3.1

- Inquiry lab- construct ellipses to model the shape of planetary orbits.

- Identify the variables that affect the strength of gravity using Gravity and Orbits Phet lab.
- Investigative Phenomenon CER

Unit Specific Accommodations and Modifications

Gifted and Talent Accommodations and Modifications:

- Allow for further independent research on topics of interest related to the unit of study
- Advanced leveled readers and sources
- Increase the level of complexity
- Decrease scaffolding
- Variety of finished products
- Allow for greater independence
- Learning stations, interest groups
- Varied texts and supplementary materials
- Use of technology
- Flexibility in assignments
- Varied questioning strategies
- Encourage research
- Strategy and flexible groups based on formative assessment or student choice
- Acceleration within a unit of study
- Exposure to more advanced or complex concepts, abstractions, and materials
- Encourage students to move through content areas at their own pace
- After mastery of a unit, provide students with more advanced learning activities, not more of the same activity
- Present information using a thematic, broad-based, and integrative content, rather than just single-subject areas

Special Education, and At-Risk Accommodations and Modifications:

- Focus on concept not details
- More visual prompts
- Leveled readers and teacher annotated sources
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies

English Language Learners:

- Focus on concept not details
- More visual prompts
- Leveled readers and teacher annotated sources
- Guided notes with highlighted words and concepts
- Use of Merriam-Webster's ELL dictionary
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in "chunks"
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

Unit Specific Interdisciplinary Connections / Materials

Mathematics: Solving equations; create table, analyze graphs

Language Arts: Write about your experiences at an amusement park where you experienced circular motion.

Earth and Space Science

Additional Materials

Digital Tools/Resources:

Savvas Experience Physics

Internet resources:

Khan Academy: https://www.khanacademy.org

Physicsclassroom.com: http://www.physicsclassroom.com/

YouTube videos

http://hyperphysics.phy-astr.gsu.edu/

Phet Simulations: http://phet.colorado.edu/en/simulation/

https://phet.colorado.edu/en/simulation/gravity-force-lab

https://phet.colorado.edu/en/simulation/gravity-and-orbits

https://phet.colorado.edu/sims/my-solar-system/my-solar-system_en.html

Unit 4: Momentum

Overview:

This unit introduces the concept of impulse, defines momentum in terms of mass and velocity and relates impulse and momentum. In any system, the total momentum is always conserved.

STAGE 1
Desired Results

Essential Questions…

- What is the momentum of an object?
- How can we change the momentum of an object?
- What are the different type of collisions?
- What is the difference between momentum and impulse?
- What is the law of conservation of momentum and how does it apply to different collisions?

Enduring Understanding…

Momentum is a physical quantity that only moving objects have. Momentum is conserved in a closed system.

Students will be able to...

- Define what momentum is and be able to calculate it for various situations.
- Define impulse and calculate the impulse delivered to an object.
- Explain the relationship between impulse and momentum.
- Explain how increasing the duration of an impact reduces the force of the impact.
- Relate the impulse exerted on an object to the change in momentum of the object.
- Express Newton's second law of motion in terms of momentum.
- Identify initial state and final state for collisions and explosions.
- State and apply the law of conservation of momentum.
- Identify situations in which linear momentum is conserved.
- Recognize that momentum is conserved in all collision problems
- Explain how conservation of momentum and conservation of kinetic energy are used to calculate the velocities of objects after an elastic collision

Students will know...

Assessment Topic #1 Momentum and Impulse

Key Terms/Vocabulary:

- Momentum
- Impulse

Main Ideas/Concepts:

- Momentum of an object is the product of its mass and its velocity.
- The change in momentum depends on the force that acts and the length of time it acts.
- For a system of several objects the total linear momentum is the vector sum of the individual momenta.
- The product of a force and the time over which it acts is defined as the impulse.
- Impulse is a vector that points in the same direction as the force.

Possible Misunderstandings:

- Momentum is the same as force.
- Momentum and kinetic energy are the same.

Assessment Topic #2 Conservation of Momentum

Key Terms/Vocabulary:

- Conservation of momentum
- Elastic collision
- Inelastic collision

Main Ideas/Concepts:

- Momentum is conserved when there is no net external force. Only external forces can cahnge a system's momentum.
- Internal forces have no effect on a system's momentum.
- The basic idea in solving any collision problem is to conserve momentum.
- A collision in which the kinetic energy is conserved is an elastic collision.
- An inelastic collision is one in which the kinetic energy changes as a result of the collision.
- An inelastic collision where the colliding objects stick together is a completely inelastic collision.
- In a two dimensional collision both the x and the y components of momentum are conserved separately.

Possible Misunderstandings:

- Students may incorrectly assume that whenever colliding objects bounce apart, the collision is elastic.
- Conservation of momentum applies only to collisions.

STAGE 2
Evidence of Learning

Formative Activities, Tasks, or Projects:

Assessment Topic #1 Momentum and Impulse

- Inquiry lab: Momentum and impulse during collisions
- Phet Simulation – Momentum and impulse

Assessment Topic #2 Conservation of Momentum

- Inquiry lab: Elastic and Inelastic collisions
- Phet Simulation – Conservation of momentum
- Egg drop experiment
- CER: elastic and inelastic collisions

Summative Activities, Tasks, or Projects:

Culminating Projects at the end of the Unit; Unit test

STAGE 3
Learning Plan

Assessment Topics and Lesson Themes:

Assessment Topic #1: Momentum and Impulse

Lesson Themes 1.1

- Define momentum and calculate the momentum of an object with a given mass and velocity
- Recognize that momentum is a vector quantity and identify the direction of the momentum vector.

Lesson Themes 1.2

- Students compare projectile data and determine if momentum is conserved in a one-dimensional collision
- Students discover the relationship between the impulse given an object and its final velocity.
- Explain that conservation of momentum is essentially a more quantitative way of stating Newton's first law: an object will not change its motion unless acted upon by an outside force. If an object's motion does not change, its momentum cannot change, meaning momentum is conserved.

Assessment Topic #2: Conservation of Momentum

Lesson Themes 2.1

- Describe a variety of physical situations; some of these situations should involve an external net force, while the others do not. Ask students to identify whether or not momentum is conserved in each situation.

Lesson Themes 2.2

- Phet Simulation- Collision lab: Apply the law of conservation of momentum to solve collision problems.
- Inquiry lab worksheets.
- Mathematical models

Unit Specific Accommodations and Modifications

Gifted and Talent Accommodations and Modifications:

- Allow for further independent research on topics of interest related to the unit of study
- Advanced leveled readers and sources
- Increase the level of complexity
- Decrease scaffolding
- Variety of finished products
- Allow for greater independence
- Learning stations, interest groups
- Varied texts and supplementary materials
- Use of technology
- Flexibility in assignments
- Varied questioning strategies
- Encourage research
- Strategy and flexible groups based on formative assessment or student choice
- Acceleration within a unit of study
- Exposure to more advanced or complex concepts, abstractions, and materials
- Encourage students to move through content areas at their own pace
- After mastery of a unit, provide students with more advanced learning activities, not more of the same activity
- Present information using a thematic, broad-based, and integrative content, rather than just single-subject areas

Special Education, and At-Risk Accommodations and Modifications:

- Focus on concept not details
- More visual prompts
- Leveled readers and teacher annotated sources
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

English Language Learners:

- Focus on concept not details
- More visual prompts
- Leveled readers and teacher annotated sources
- Guided notes with highlighted words and concepts
- Use of Merriam-Webster’s ELL dictionary
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials

- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

Unit Specific Interdisciplinary Connections / Materials

- Mathematics: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
- Students studying other science subject will be able to use these skills across all subjects.
- Language Arts: For an activity in this unit write a lab report.

- Social Studies: Discuss different designs created over the centuries to launch projectiles.

Additional Materials

Digital Tools/Resources:

Savvas Experience Physics

Internet resources:

Khan Academy: https://www.khanacademy.org

Physicsclassroom.com: http://www.physicsclassroom.com/

YouTube videos

http://hyperphysics.phy-astr.gsu.edu/

Phet Simulations: http://phet.colorado.edu/en/simulation/

https://phet.colorado.edu/en/simulation/forces-and-motion-basics

https://phet.colorado.edu/en/simulation/mass-spring-lab

https://phet.colorado.edu/en/simulation/collision-lab

Unit 5: Energy

Overview:

The fundamental concept of energy is the basis upon which much of science is built. What is **energy**? Where is energy located? Can energy be transferred from one object to another? How is energy created? Can energy be destroyed? What happens if energy is 'used up'? Is energy always available to us?
Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. Students will understand that work and power describe how the external world changes the energy of a system. Students will understand that energy changes from one form to another, and that the total amount of energy in a closed system remains constant.

STAGE 1
Desired Results

Essential Questions…

- What is work and how do we quantify it?
- What is power and how is it calculated?
- What are the different forms of energy?
- How are work and energy related?
- How can the conservation of energy in a system be represented graphically and mathematically?
- Why do your hands feel warmer when you rub them together?

Enduring Understanding…

Energy is a property of objects and substances that exists and can be transferred between many forms. Energy is conserved in a closed system.

Students will be able to...

- Identify situations where work is being done.
- Calculate the work done on an object when the force applied to the object is in the same direction as the object's displacement
- Recognize that the amount of force that does work on an object depends on the angle between the force on and the displacement of the object.
- Calculate the kinetic energy of an object and relate this quantity to the work done on the object.
- Describe the potential energy of an object and calculate the gravitational potential energy stored by an object.
- Show that work and energy have the same units.
- Understand potential energy as the energy of position.
- Write the expression and solve problems for kinetic energy.

- Apply the Law of Conservation of Energy to predict the quantities that describe motion.
- Define conservation of energy and explain how different physical quantities can be calculated when mechanical energy is conserved
- Understand the work - energy theorem.
- Calculate power and recognize that it is a change in energy or work within a given time frame.
- Explain how power, force, and speed are related.

Students will know...

Assessment Topic #1 Work, Energy, and Power

Key Terms/Vocabulary:

- Work
- Joule
- Energy
- Power
- Kinetic energy
- Potential energy

Main Ideas/Concepts:

- Work is done when a force is applied to an object and the object moves in the direction of the applied force.
- Only the component of the force in the direction of the displacement does work.
- If more than one force does work, the total work is the sum of the amounts of work done by the forces separately.
- Kinetic energy increases linearly with mass and with the square of the velocity.
- The total work done on an object equals the change in kinetic energy.
- The potential energy of an object is determined by the amount of work required to move it from one location to another.
- The faster work is done, the greatyer the power.
- Power is equal to force times speed.

Possible Misunderstandings:

- Energy is a force.
- Energy gets used up or runs out.
- Something that is not moving can't have any energy.
- A force acting on an object does work even if the object does not move.

Assessment Topic #2 Conservation of Energy

Key Terms/Vocabulary:

Main Ideas/Concepts:

- Energy is constantly being transferred and transformed in the natural world.
- Energy cannot be created or destroyed.
- The sum of the potential and kinetic energies of an object is its mechanical energy.

Possible Misunderstandings:

- Energy is destroyed in transformations from one type to another.
- Gravitational potential energy is the only type of potential energy.
- When an object is released to fall, the gravitational potential energy immediately becomes all kinetic energy.

STAGE 2
Evidence of Learning

Formative Activities, Tasks, or Projects:

Assessment Topic #1 Work, Energy, and Power

- Identify the different types of energy involved in a few familiar examples.
- Inquiry Lab: Gas particles and work.
- Analyzing Data: Hooke's law and elastic potential energy
- Phet Simulation: Classifying energy and work
- Quiz

Assessment Topic #2 Conservation of Energy

- Inquiry lab: Pendulums and the conservation of energy
- Analyzing Data: Simple Harmonic Motion
- Phet Simulation: Conservation of energy
- Quiz

Summative Activities, Tasks, or Projects:

Culminating Projects at the end of the Unit; Unit Test

STAGE 3
Learning Plan

Assessment Topics and Lesson Themes:

Assessment Topic #1: Work, Energy, and Power

Lesson Themes 1.1

- Describe what happens to the kinetic energy of a car as its velocity increases and what happens to the gravitational potential energy of a hot air balloon as it rises in the sky.
- Investigative phenomenon CER
- Inquiry lab worksheets

Assessment Topic #2: Conservation of Energy

Lesson Themes 2.1

- Pendulums and the conservation of energy worksheet
- Phet simulation: Energy Skate park worksheet

- Phet simulation: Masses and springs

Unit Specific Accommodations and Modifications

Gifted and Talent Accommodations and Modifications:

- Allow for further independent research on topics of interest related to the unit of study
- Advanced leveled readers and sources
- Increase the level of complexity
- Decrease scaffolding
- Variety of finished products
- Allow for greater independence
- Learning stations, interest groups
- Varied texts and supplementary materials
- Use of technology
- Flexibility in assignments
- Varied questioning strategies
- Encourage research
- Strategy and flexible groups based on formative assessment or student choice
- Acceleration within a unit of study
- Exposure to more advanced or complex concepts, abstractions, and materials
- Encourage students to move through content areas at their own pace
- After mastery of a unit, provide students with more advanced learning activities, not more of the same activity
- Present information using a thematic, broad-based, and integrative content, rather than just single-subject areas

Special Education, and At-Risk Accommodations and Modifications:

- Focus on concept not details
- More visual prompts
- Leveled readers and teacher annotated sources
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary

- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

English Language Learners:

- Focus on concept not details
- More visual prompts
- Leveled readers and teacher annotated sources
- Guided notes with highlighted words and concepts
- Use of Merriam-Webster's ELL dictionary
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in "chunks"
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

Unit Specific Interdisciplinary Connections / Materials

Chemistry: Energy transfer

Mathematics: Solving equations

Language Arts: Reading and comprehending science magazines

Additional Materials

Digital Tools/Resources:

Savvas Experience Physics

Internet resources:

Khan Academy: https://www.khanacademy.org

Physicsclassroom.com: http://www.physicsclassroom.com/

YouTube videos

Phet Simulations: http://phet.colorado.edu/en/simulation/

https://phet.colorado.edu/en/simulation/mass-spring-lab

https://phet.colorado.edu/en/simulation/energy-skate-park-basics

https://phet.colorado.edu/en/simulation/collision-lab

http://hyperphysics.phy-astr.gsu.edu/

http://vcephysics.com/content/

Unit 6: Electricity and Magnetism

Overview:

One of the earliest uses of electricity at around the year 1900 was to produce light and heat. Electrical technology continues to have a major impact, far beyond those applications on the lives of people everywhere. The basic properties of electrical interaction are introduced in this unit. Electricity is the study of electric charges, and electric charges create electric fields in space. The notion of electric field and the related concept of electric potential, and electric potential energy are introduced and discussed in this section. The motion of electric charges creates electric currents. How to read and draw schematic circuit diagrams, and the relationship of current, voltage and resistance in Ohm's law are also presented. Permanent magnets and electromagnets are used in many everyday and scientific applications. Generators and motors are devices that convert energy from one form to another.

STAGE 1
Desired Results

Essential Questions…

- How do charges interact with electric and magnetic fields?
- Why are most objects electrically neutral?
- How does the total amount of charge in the universe change over time?
- How is the electrostatic force between two charges related to the magnitude of the charges and the distance between them?
- How is the direction of the electric force determined?
- How much electric force acts between two charged objects?
- How is the total electric force on a charge determined?
- How is the sign of an electric charge related to the electric field it produces?
- How do you calculate the electric field for a system of two or more charges?
- What is the electric field inside a charged conductor?
- When is mechanical work done in an electrical system?
- Relative to the electric field, in what direction does the electric potential decrease?
- How is capacitance related to the charge and the voltage of a capacitor?
- How do electrons move through a DC circuit?
- How is the voltage across a resistor related to the current through the resistor?
- What factors affect the resistance of a wire?
- How does adding another resistor in series affect the resistance?
- How is electrical power calculated?
- What quantity does the electric company use for billing?
- How are the north and south poles of a magnet defined?
- How is the direction of a magnetic field determined?
- How is the direction of the magnetic field around a current-carrying wire determined?
- How is the strength of the magnetic field is calculated?
- How is an induced emf related to a magnetic field?
- What determines the direction of an induced current?

- How does an electric generator produce an emf?

Enduring Understanding…

Forces at a distance are explained by fields permeating space that can transfer energy through space. Magnets or changing electric fields cause magnetic fields. Electric charges or changing magnetic fields cause electric fields. The effect scientists call magnetism arises when one charge moves in the vicinity of another moving charge.

Students will be able to...

- Describe the basic properties of electric charge.
- Explain how an object becomes positively charged and negatively charged.
- Distinguish between a conductor and an insulator.
- Distinguish between charging by contact, charging by induction, and charging by polarization.
- Calculate electric force using Coulomb's Law.
- Compare electric force with gravitational force.
- Calculate electric field strength.
- Draw and interpret electric field lines.
- Distinguish between electrical potential energy and electric potential.
- Solve problems involving electrical energy and potential difference.
- Describe the energy conversions that occur in a battery.
- Describe how electrical energy can be stored.
- Describe the flow of electric charge.
- Calculate resistance, current and potential difference by using the definition of resistance.
- Distinguish between ohmic and non-ohmic conductors.
- Calculate electric power and the cost of running electrical appliances.
- Interpret and construct circuit diagrams.
- Calculate the equivalent resistance for a circuit of resistors in series and in parallel.
- Describe the magnetic field around a permanent magnet.
- Describe the magnetic field produced by current in a straight conductor and in a solenoid.
- Given the force on a charge in a magnetic field, determine the strength of the magnetic field.
- Recognize that relative motion between a conductor and a magnetic field induces an emf in the conductor.
- Describe how generators and motors operate.

- Explain the energy conversions that take place in generators and motors.

Students will know...

Assessment Topic #1 Electric charges and forces

Key Terms/Vocabulary:
- Neutral
- Coulomb
- Charge quantization
- Insulator
- Conductor
- Semiconductor
- Coulomb's Law

Main Ideas/Concepts:

- Most everyday objects are electrically neutral because they contain equal amounts of positive and negative charge.
- Since electrons always have the charge -e and protons always have the charge +e, all objects must have a total charge that is an integer multiple of e. Charge quantization means electric charge comes in amounts that are always integer multiples of e.
- Electric charge is conserved. The total electric charge in the universe is constant.
- The SI unit of charge is the coulomb.
- Conductors allow the flow of electric charge; insulators prevent the flow of electric charge.
- The electrical force between two charged objects is proportional to the product of the charges and inversely proportional to the square of the distance between them.
- Magnetic, electrical, and gravitational forces can act at a distance, and obey the inverse square law.

Possible Misunderstandings:
- Charge is continuous and can occur in any amount.
- Coulomb's law applies to charge systems consisting of something other than point charges.
- A charged body has only one type of charge.

Assessment Topic #2 Electric fields and electric energy

Key Terms/Vocabulary:
- Electric Field
- Electric Dipole
- Charging by Induction
- Electric potential
- Electric potential energy
- Capacitor
- Capacitance

Main Ideas/Concepts:
- The force field produced by a charged object is referred to as the electric field.
- The direction of an electric field is away from a positive charge and toward a negative charge.
- The electric field is the force per charge at a given location in space.
- A system of two equal and opposite charges separated by a finite distance is known as an electric dipole.
- A conductor can be charged without having direct physical contact with another charged object.

- When a system consists of several charges, the total electric field is the vector sum of the electric field due to the individual charge.
- Separating two charges that attract each other, or moving two charges that repel each other closer together requires mechanical work. This work is stored in the electric field as electric potential energy.
- The greater the charge for a given voltage, the greater the capacitance of the capacitor.
- Increasing a capacitor's charge or voltage increases its stored energy.
- Moving electric charges produce magnetic fields.

Possible Misunderstandings:

- Field lines are real.
- Field lines can begin/end anywhere.
- Field lines exist only in two dimensions.

Assessment Topic #3 Electric current and circuits

Key Terms/Vocabulary:

- Electric current
- Ampere
- Potential difference
- Ohm's Law
- Electric resistance
- Electric Power
- Resistivity

Main Ideas/Concepts:

- Electric current is the rate of flow of charges.
- The unit of electric current is the ampere.
- The amount of current is directly proportional to the voltage and inversely proportional to the resistance.
- A thicker wire decreases resistance.
- The resistivity of a material determines how much resistance it offers to the flow of electric current.
- The electric power used by a device is equal to the current times the voltage.

Possible Misunderstandings:

- A conductor has no resistance.
- Charges slow down as they go through a resistor.
- Current gets "used up" as it flows through a circuit.
- Power and energy are the same thing
- Charges that flow in circuit are from the battery.

Assessment Topic #4 Magnetism and electromagnetic Induction

- Key Terms/Vocabulary:
- Magnetic Field
- Electromagnet
- Solenoid

Main Ideas/Concepts:

- The direction of a magnetic Field at a given location is defined as the direction a compass needle would point if placed at that location.

- An electric current produces a magnetic field.
- The magnetic field produced by a current in a wire is proportional to the current and inversly proportional to the distance from the wire.

Possible Misunderstandings:

- North and south magnetic poles are the same as positive and negative charges.
- Magnetic fields are two dimensional like the pictures in the book.
- Only magnets have magnetic fields.

STAGE 2
Evidence of Learning

Formative Activities, Tasks, or Projects:

Assessment Topic #1 Electric charges and forces

- Phet simulation- Balloons and static electricity
- Relate the electrostatic force magnitude to the charges and the distance between them
- Phet Simulation- Coulomb's Law : Determine Coulomb's law constant
- Quiz

Assessment Topic #2 Electric fields and electric energy

- Phet Simulation- Charges and Fields
- Determine the variables that affect the strength and direction of the electric field for a static arrangement of charges.
- Investigate the variables that affect the strength of the electrostatic potential (voltage).
- Describe and draw models for common static electricity concepts (transfer of charge, induction, attraction, repulsion, and grounding)
- Quiz

Assessment Topic #3 Electric current and circuits

- Predict how current will change when resistance of the circuit is fixed, and voltage is varied.
- Predict how current will change when voltage of the circuit is fixed, and resistance is varied.
- Phet Simulation lab: Ohm's law
- Phet Simulation lab: Resistance in a wire data analysis
- Resistance and resistivity worksheet

Assessment Topic #4 Magnetism and electromagnetic Induction

- Phet Simulation lab- Faraday's Law
- Explain what happens when the magnet moves through the coil at different speeds and how this affects the brightness of the bulb and the magnitude & sign of the voltage.

- Explain the difference between moving the magnet through the coil from the right side versus the left side.
- Explain the difference between moving magnet through the big coil versus the smaller coil.
- Quiz

Summative Activities, Tasks, or Projects:

Unit test
Lab report

STAGE 3
Learning Plan

Assessment Topics and Lesson Themes:

Assessment Topic #1: Electric charges and forces

Lesson Themes 1.1 Electric charges

- Phet Simulation – Balloons and electrostatic charges: Describe and draw models for common static electricity concepts (transfer of charge, induction, attraction, repulsion, and grounding)
- Make predictions about force at a distance for various configurations of charge

Lesson Themes 1.2: Coulomb's Law

- Phet Simulation – Coulomb's Law: Relate the electrostatic force magnitude to the charges and the distance between them; Explain Newton's third law for electrostatic forces; Use measurements to determine Coulomb's constant.
- Modelling worksheet

Assessment Topic #2: Electric fields and electric energy

Lesson Themes 2.1: Electric Fields

- Phet Simulation - Charhges and Fields: Determine the variables that affect the strength and direction of the electric field for a static arrangement of charges.
- Investigate the variables that affect the strength of the electrostatic potential (voltage).
- For an arrangement of static charges, predict the electric field lines. Verify the prediction using vector addition.

Lesson Themes 2.2: Electric energy

- Inquiry lab: Build a battery
- Phet simulation- Electric potential

Assessment Topic #3: Electric current and circuits

Lesson Themes 3.1: Electric current, Potential difference, and resistance

- Inquiry lab: Energy Transmission in circuits
- Analyzing data: Electric circuits
- Phet simulation: Energy in electric circuits

Lesson Themes 3.2: Electric power

- Inquiry lab: Electric Motors and Generators
- Phet simulation: Power Generation
- CER: Properties of electric motors

Assessment Topic #4: Magnetism and electromagnetic Induction

Lesson Themes 4.1: Magnetic Field

- Inquiry lab: Magnetic Force and separation distance
- Phet Simulation- Magnetism

Lesson Themes 4.2: Electromagnetic Induction

- Inquiry lab: Induction of electric current
- Phet Simulation: Faraday's law
- CER Worksheet – Magnetic forces

Unit Specific Accommodations and Modifications

Gifted and Talent Accommodations and Modifications:

- Allow for further independent research on topics of interest related to the unit of study
- Advanced leveled readers and sources
- Increase the level of complexity
- Decrease scaffolding
- Variety of finished products
- Allow for greater independence
- Learning stations, interest groups
- Varied texts and supplementary materials
- Use of technology
- Flexibility in assignments
- Varied questioning strategies
- Encourage research
- Strategy and flexible groups based on formative assessment or student choice
- Acceleration within a unit of study
- Exposure to more advanced or complex concepts, abstractions, and materials
- Encourage students to move through content areas at their own pace
- After mastery of a unit, provide students with more advanced learning activities, not more of the same activity
- Present information using a thematic, broad-based, and integrative content, rather than just single-subject areas

Special Education, and At-Risk Accommodations and Modifications:

- Focus on concept not details
- More visual prompts
- Leveled readers and teacher annotated sources
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content

- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

<u>English Language Learners:</u>

- Focus on concept not details
- More visual prompts
- Leveled readers and teacher annotated sources
- Guided notes with highlighted words and concepts
- Use of Merriam-Webster’s ELL dictionary
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
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- Differentiated checklists and rubrics, if available and appropriate

Unit Specific Interdisciplinary Connections / Materials

- Chemistry: Transferring energy from one place to another
- Social studies: Impact on the environment from electricity generation; Research historical sources of electricity; how electricity influenced human history
- Language Arts: Write scientific report
- Mathematics: Analyzing graphs; solving problems

Additional Materials

Digital Tools/Resources:

- Savvas Experience Physics

- Internet resources:
- Khan Academy: https://www.khanacademy.org
- Physicsclassroom.com: http://www.physicsclassroom.com/
- Phet Simulations: http://phet.colorado.edu/en/simulation/
- https://phet.colorado.edu/en/simulation/balloons-and-static-electricity
- https://phet.colorado.edu/en/simulation/john-travoltage
- https://phet.colorado.edu/en/simulations/coulombs-law
- https://phet.colorado.edu/en/simulation/charges-and-fields
- https://phet.colorado.edu/en/simulation/capacitor-lab
- https://phet.colorado.edu/en/simulation/ohms-law
- https://phet.colorado.edu/en/simulation/resistance-in-a-wire
- https://phet.colorado.edu/en/simulation/magnets-and-electromagnets
- https://phet.colorado.edu/en/simulation/faraday
- https://phet.colorado.edu/en/simulation/generator
- YouTube videos
- http://hyperphysics.phy-astr.gsu.edu/

Unit 7: Wave Properties

Overview:

There are many forms of waves available to be studied. A common characteristic of all traveling waves is that they carry energy, but generally the medium through which they travel will not be permanently disturbed. All waves can be described by the same sets of mathematical ideas. Detailed knowledge of one area leads to the possibility of prediction in another. Waves interact with media and each other in a number of ways that can be unexpected and useful. When traveling waves meet, they can superpose to form standing waves in which energy may not be transferred.

STAGE 1
Desired Results

Essential Questions…

- What are the defining properties of a wave?
- How are the period and frequency of periodic motion related?
- What factors affect the period of a pendulum?
- What determines the speed of a wave?
- How do overlapping waves interact with one another?
- How does a standing wave form?
- How is sound wave produced?
- What causes beats?
- What gives light its particle like properties?
- How are light waves produced?
- How do waves change direction and shape in their encounters with materials that they can or cannot penetrate and travel through

Enduring Understanding…

Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter. By understanding wave properties and the interactions of electromagnetic radiation with matter, scientists and engineers can design systems for transferring information across long distance and storing information.

Students will be able to...

- Identify periodic motion of a particle both verbally and graphically.
- Define a wave and assign properties.
- Describe the difference between transverse wave and longitudinal wave.

- Define amplitude, frequency, period, wavelength, and wave speed of a wave.
- Calculate wave speed.
- Apply the principle of superposition to predict interference effects.
- Use concepts of reflection and interference to describe how standing waves are formed.
- Describe the properties of sound.
- Describe how the principle of superposition can be applied to sound waves.

Students will know...

Assessment Topic #1. Oscillations and Periodic Motion

Key Terms/Vocabulary:

- Periodic Motion
- Period
- Frequency
- Amplitude
- Simple Harmonic Motion
- Simple Pendulum

Main Ideas/Concepts:

- Any motion that repeats itself over and over is periodic motion.
- Frequency is calculated by taking the inverse of the period.
- Simple harmonic motion occurs when the restoring force is proportional to the displacement from the equilibrium position.
- The period of a pendulum depends on its length and its acceleration due to gravity.
- The period of a mass on a spring depends on both the mass and the spring constant.
- Waves transfer energy without transferring matter.
- The speed, wavelength and frequency of waves are interrelated
- Sound waves are pressure waves moving through media.

Possible Misunderstandings:

- The period of a pendulum is affected by its mass and the amplitude of its swing.
- Waves transport matter.
- There must be a medium for a wave to travel through.
- Waves do not have energy.
- All waves travel the same way.
- Frequency is connected to loudness for all amplitudes.
- Big waves travel faster than small waves in the same medium.
- Different colors of light are different types of waves.
-

Assessment Topic #2 Wave properties

Key Terms/Vocabulary:

- Transverse Wave
- Longitudinal wave
- Mechanical wave
- Wavelength
- Interference
- Standing wave
- Doppler effect
- Reflection
- Refraction

Main Ideas/Concepts:

- The speed of a wave is determined by the properties of the material, or medium, through which it travels.
- In a transverse wave the individual particles move at right angles to the direction of the wave motion.
- In a longitudinal wave the individual particles move in the same direction as the wave motion.
- The wavelength is the distance between successive identical parts of the wave.
- Interference patterns occur when waves from different sources arrive at the same point at the same time.
- All standing waves are the result of interference.
- Doppler effect is an observed shift in frequency received due to motion of a vibrating source toward or away from a receiver.

Possible Misunderstandings:

- There must be a medium for a wave to travel through.
- In refraction, the frequency (color) of light changes.

STAGE 2
Evidence of Learning

Formative Activities, Tasks, or Projects:

Assessment Topic #1. Oscillations and Periodic Motion

- Acceleration due to gravity lab using a simple pendulum
- Masses and springs lab using Phet

Assessment Topic #2 Wave properties

- Inquiry lab: Mechanical waves
- Phet simulation: Properties of waves
- CER: Wave speed
- Speed of sound in air lab
- Refractive Index of the material lab

Summative Activities, Tasks, or Projects:
Unit Test, project, lab report

STAGE 3
Learning Plan

Assessment Topics and Lesson Themes:

Introduction of the Unit:

Assessment Topic #1: . Oscillations and Periodic Motion

Lesson Themes 1.1 Simple harmonic motion

- Lab report: Acceleration due to gravity using a simple pendulum
- Phet Simulation- Masses and Springs

Assessment Topic #2: Wave properties

Lesson Themes 2.1: Reflection and Refraction

- Inquiry lab: Reflection and Refraction
- Analyzing Data: Refraction- Snell's Law
- Phet Simulation: Wave Optics

Lesson Themes 2.2: Interference and standing waves

- Inquiry lab: Interference of sound waves
- Phet Simulation: Wave behavior and energy
- CER worksheet: Waves

Unit Wrap-Up:

Unit Specific Accommodations and Modifications

Gifted and Talent Accommodations and Modifications:

- Allow for further independent research on topics of interest related to the unit of study
- Advanced leveled readers and sources
- Increase the level of complexity
- Decrease scaffolding
- Variety of finished products
- Allow for greater independence
- Learning stations, interest groups
- Varied texts and supplementary materials
- Use of technology
- Flexibility in assignments
- Varied questioning strategies
- Encourage research
- Strategy and flexible groups based on formative assessment or student choice

- Acceleration within a unit of study
- Exposure to more advanced or complex concepts, abstractions, and materials
- Encourage students to move through content areas at their own pace
- After mastery of a unit, provide students with more advanced learning activities, not more of the same activity
- Present information using a thematic, broad-based, and integrative content, rather than just single-subject areas

Special Education, and At-Risk Accommodations and Modifications:

- Focus on concept not details
- More visual prompts
- Leveled readers and teacher annotated sources
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

English Language Learners:

- Focus on concept not details
- More visual prompts
- Leveled readers and teacher annotated sources
- Guided notes with highlighted words and concepts
- Use of Merriam-Webster’s ELL dictionary
- Timelines and graphic organizers
- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials

- Provide appropriate scaffolding
- Limit the number of steps required for completion
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- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

Unit Specific Interdisciplinary Connections / Materials

- Mathematics: Trigonometric functions; Graphical analysis
- Social Studies: Investigate businesses that use applied wave technology
- Chemistry: Electromagnetic spectrum
- Biology: Effect of light on plants
- Music: Musical notes and instruments
- Art: Understanding color
- Technology

Additional Materials

Digital Tools/Resources:

- Savvas Experience Physics
- Internet resources:
- Khan Academy: https://www.khanacademy.org

- Physicsclassroom.com: http://www.physicsclassroom.com/
- YouTube videos
- http://hyperphysics.phy-astr.gsu.edu/
- Phet Simulations: http://phet.colorado.edu/en/simulation/
- https://phet.colorado.edu/en/simulation/wave-on-a-string
- https://phet.colorado.edu/en/simulation/sound
- https://phet.colorado.edu/en/simulation/wave-interference
- https://phet.colorado.edu/en/simulation/bending-light
- https://phet.colorado.edu/en/simulation/photoelectric

Unit 8: Electromagnetic Radiation

Overview:

In this unit of study, students can apply their understanding of wave properties to make sense of how electromagnetic radiation can be used to transfer information across long distances, store information, and be used to investigate nature on many scales. Models of electromagnetic radiation as both a wave of changing electrical and magnetic fields or as particles are developed and used. Waves can carry information, such as conversations and television broadcasts. Some animals use sound waves to learn about their prey. Communication, the transfer of information in many different forms from one place to another, is the dominant characteristic of our present global society. We are now all dependent on computers, modems, and mobile phones. Analogue and digital signals are introduced with their advantages and disadvantages in signal transmission. Optical fiber communication is also introduced.

STAGE 1
Desired Results

Essential Questions…

- What is electromagnetic radiation?
- How can electromagnetic radiation be both a wave and a particle at the same time?
- How does the International Space Station power all of its equipment?
- How do astronauts communicate with people on the ground?
- What are the advantages of the storage of information in digital rather than analogue form?
- What are the relative advantages and disadvantages of AM and FM for radio transmission and reception?

Enduring Understanding…

Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter. By understanding wave properties and the interactions of electromagnetic radiation with matter, scientists and engineers can design systems for transferring information across long distance and storing information.

Students will be able to...

- Describe what electromagnetic waves are and how they are produced.
- Describe different regions of the electromagnetic spectrum.
- Explain how electromagnetic waves transfer energy.
- Describe various applications of electromagnetic waves.
- Describe diffraction and interference.
- Describe the photoelectric effect.
- State the meaning of the term *wave-particle duality.*
- State the difference between an analogue signal and a digital signal
- Describe the advantage of the storage of information in digital rather than the analogue form.
- Describe the nature of amplitude modulation and frequency modulation.
- Explain standard x-ray imaging technique used in medicine.

Students will know...

Assessment Topic #1 Electromagnetic radiation

Key Terms/Vocabulary:

- The electromagnetic radiation
- The electromagnetic spectrum
- Diffraction

Main Ideas/Concepts:

- Electromagnetic radiation can be modeled as a wave of changing electric and magnetic fields or as particles called photons
- Electromagnetic spectrum consists of the range of electromagnetic waves extending in frequency from radio waves to gamma rays.
- Visible light waves comprise a small part of the electromagnetic spectrum. Our perception of color is related to wavelength.

Possible Misunderstandings:

- Light waves and radio waves are not the same thing.
- In refraction, the characteristics of light change.
- The speed of light never changes.
- Rays and wave fronts are the same thing.

- There is no interaction between light and matter.

Assessment Topic #2 Particle – Wave duality

Key Terms/Vocabulary:

- Photon
- Photoelectric Effect
- Interference and Diffraction

Main Ideas/Concepts:

- A photon is a zero rest mass neutral particle, the quantum of electromagnetic radiation. The energy of a photon is E = hf
- Photoelectric effect is the emission of electrons from a metallic surface when electromagnetic radiation is incident on the surface.
- The photoelectric effect can only be explained by the particle nature of light.
- The wave model of light is useful for describing interference and diffraction phenomena.
- When light or longer wavelength electromagnetic radiation is absorbed on matter, it is generally converted into thermal energy. Shorter wavelength electromagnetic radiation can ionize atoms and cause damage to living cells.

Possible Misunderstandings:

- A photon is a particle with a wave inside.
- Photons of higher frequency are bigger than photons of lower frequency.
- All photons have the same energy

Assessment Topic #3 Information and Instrumentation

Key Terms/Vocabulary:

- Analogue and Digital Signals
- Channels of Communication
- Encode

Main Ideas/Concepts:

- Analogue signals are continuous signals, varying between two extreme values in a way that is proportional to the physical mechanism that created the signal.
- A digital signal is a coded form of a signal that takes the discrete values 0 or 1 only.
- Information can be digitized; in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses.

STAGE 2
Evidence of Learning

Formative Activities, Tasks, or Projects:

Assessment Topic #1 Electromagnetic radiation

- Inquiry lab: Diffraction
- Phet Simulation: Electromagnetic waves and their properties
- CER: Laser Interference
- Quiz

Assessment Topic #2 Particle – Wave duality

- Inquiry lab: Particle nature of light
- Phet Simulation: Photoelectric effect
- Analyzing data: Particle – wave duality
- Quiz

Assessment Topic #3 Information and Instrumentation

- Inquiry lab: Binary Logic
- Phet simulation: Capturing and transmitting information and energy
- CER: Solar panels on a cloudy day
- Phet Simulation: Energy Forms and Changes
- Quiz

Summative Activities, Tasks, or Projects:

- Investigation assessment, Unit test.
- Research the effects of radiation on human health.

STAGE 3
Learning Plan

Assessment Topics and Lesson Themes:

Introduction of the Unit:

Assessment Topic #1: **Electromagnetic radiation**
Lesson Themes 1.1 Electromagnetic radiation

- Use models to simulate electromagnetic radiation systems and interactions within and between systems at different scales.

Lesson Themes 1.2 Electromagnetic spectrum

- Compare absorption and emission spectra.

Assessment Topic #2: **Particle – Wave duality**
Lesson Themes 2.1 Interference and diffraction

- Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model.

Lesson Themes 2.2 Photoelectric effect

- Phet Simulation lab- Photo electric effect

Assessment Topic #3: **Information and Instrumentation**

Lesson Themes 2.1: Wave interaction with matter

- Inquiry lab worksheets
- CER worksheet: Information and Instrumentation

Lesson Themes 2.2 Analogue and digital signals.

- Phet Simulation: Use electrical circuits to transmit binary codes.

Unit Wrap-Up:

Unit Specific Accommodations and Modifications

Gifted and Talent Accommodations and Modifications:

- Allow for further independent research on topics of interest related to the unit of study
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Unit Specific Interdisciplinary Connections / Materials

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- https://phet.colorado.edu/en/simulations/molecules-and-light
- https://phet.colorado.edu/en/simulations/photoelectric

Horizontal Integration/Interdisciplinary Connections:

See Appendix