*** Unit 1 - Constant Velocity Kinematics ***

Content Area:	**Science**
Course(s):	**CP PHYSICS**
Time Period:	**Marking Period 1**
Length:	**5 weeks**
Status:	**Published**

Standards and Phenomena

Science Standards

HE.9-12.2.1.12.EH.1	Recognize one’s personal traits, strengths, and limitations and identify how to develop skills to support a healthy lifestyle.
HE.9-12.2.1.12.EH.3	Describe strategies to appropriately respond to stressors in a variety of situations (e.g., academics, relationships, shootings, death, car accidents, illness).
HE.9-12.2.1.12.SSH.4	Demonstrate strategies to prevent, manage, or resolve interpersonal conflicts without harming self or others (defining and understanding the laws of consent and dating violence).
SCI.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.
	Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.
	If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.
	If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.
	Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Phenomena

Science and Engineering Practices

Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Use a model to predict the relationships between systems or between components of a system.

Use mathematical representations of phenomena to describe explanations.

Constructing explanations and designing solutions 9–12 builds on K – experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.

Disciplinary Core Ideas

Newton's second law accurately predicts changes in the motion of macroscopic objects.

If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.

Crosscutting Concepts

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Much of science deals with constructing explanations of how things change and how they remain stable.

Transfer Goals

Students will design an experiment to find a relationship between position and time of a constant velocity buggy using the available measurement tools(stopwatches, and meterstick) Students will use the Vernier graphical analysis software tool called LoggerPro to derive a linear mathematical model for the relationship. They will develop graphical, symbolic, and mathematical representations for the constant velocity model which can be used to predict when a buggy will reach a specified position knowing its constant velocity.

Concepts

Essential Questions

- How can I use data to construct a model?
- How can I validate my model?
- Aren't scalars(distance and speed) good enough to predict a buggy's position at any point or time?
- What is the difference between speed and velocity?
- Why are vectors(displacement, velocity) needed to explain motion?
- How can you use physics to predict where a constant velocity buggy is at any point or time?

Understandings

Constant motion does not need an agent(force) to sustain it.

An object resists acceleration from a state of rest, because of the property of inertness, not because of friction.

Velocity and speed are not identical quantities.

Distance and displacement are the not same quantities.

If an object is on the negative side of the origin and moving toward the origin with positive velocity, students think that the object is moving in the negative direction, because the graph line is in the negative direction.

Critical Knowledge and Skills

Knowledge

Students will know:

- How to quantify direction.
- How a motion map can show the difference between a fast buggy and a slow buggy.
- How to choose the origin and positive direction for a system.
- How to discern the difference between a vector and a scalar.

Skills

Students will be able to:

- Access and quantify measurement uncertainty of position and time and how it affects the calculation of velocity.
- Annotate a graph using Δt and Δv.
- Average velocity – move a certain distance in the appropriate direction from the origin very one second.
- Derive 1 D kinematic equation of x = x(t) using a velocity vs. time graph.
- Determine the appropriate number of data points to insure confidence in your data analysis?
- Determine the displacement of an object graphically with a velocity vs. time graph(find the area) and with an equation.
- Determine the position of an object at a given time using appropriate graphs first, then with equations.
- Draw a velocity vs. time graph, determine its slope and interpret its meaning.
- Given a position vs time graph, derive the velocity versus time graph and vice versa.
- Interpret the slope of a position versus time graph of a constant velocity buggy as its average velocity.
- Use the slope intercept form to write an equation for the position of an object.
- Use words, graphs, and motion maps to explain motion.
- Walk motion with a motion sensor when given an x vs t graph or a v vs. t graph.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

Linear & Non-Linear Relationships on Logger Pro

Developing a Linear Mathematical & Graphical Model

"Motion" Picture Walk (1 period)

"Describing Motion" Web Quest Part 1 – Physics Classroom

PHET Simulations

Tumble Buggy Lab

AMTA Practice / White Board discussion

Graph Matching w/ Vernier Motion Sensors and Logger Pro Unit Test Review

School Summative Assessment Plan

PBA – Tumble Buggy Graph Matching

Quiz A – Motion Maps & Graphing Constant Velocity

Quiz B - Position vs Time and Velocity vs Time Graphs

PBA – PHET Simulation "Moving Man" Graph Matching

Unit 1 Test

Performance Assessment: Given a "fast" buggy and a "slow" buggy, start the slow buggy 40 cm away from a T interesection, where does one place the "fast" buggy such that when both are released simultaneously, they collide in the T intersection.

Primary Resources

AMTA Modeling Physics Program(2013)

http://modelinginstruction.org/

Rutgers Physics Unified Mathematics(PUM) online resources

http://pum.rutgers.edu/

Honors Physics:

College Physics by Etkina Pearson 2014 online textbook which includes

“The Active Learning Guide” (ALG)

Google Classroom

Supplementary Resources

Additional outside Resources:

Phet Simulations

https://phet.colorado.edu/en/simulation/legacy/moving-man

Vernier Ultrasonic Sensors(Motion, Force, Photogates)

Teacher designed powerpoints and/or Google Docs

TIPERs Sensemaking Tasks for Introductory Physics Pearson 2015

Direct Measurement Videos serc.carleton.edu/dmvideos/index.html

The Universe and More http://theuniverseandmore.com/

The Physics Classroom http://www.physicsclassroom.com/

Technology Integration and Differentiated Instruction

Technology Integration

Google Products

Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)

GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

One to One Student's laptop

All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

PhET - Founded in 2002 by Nobel Laureate Carl Wieman, the PhET Interactive Simulations project at the University of Colorado Boulder creates free interactive math and science simulations. PhET sims are based on extensive education research and engage students through an intuitive, game-like environment where students learn through exploration and discovery.

The Physics Classroom - The Physics Classroom is an online, free to use physics website developed primarily for beginning physics students and their teachers. The website features a variety of sections intended to support both teachers and students in the tasks of learning and teaching physics.

Additional Support Videos

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be viewed either in the classroom on the Smart Board or through links created on the Google Classroom.

The Physics Circus - a video collection produced through the University of Minnesota Physics Department Faculty.

Khan Academy

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

All assignments have been created in the student's native language.

Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH -

- MP1 Make sense of problems and persevere in solving them. MP 2. Reason Abstractly and quantitatively. MP4 Model with Mathematics. MP5 Use appropriate tools strategically.

ELA -

- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a problem or solve a problem.

- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text verofying the data when possible, and corroborating or challenging conclusions with other sources of information.

- RST.11_12.9 Synthesize information from a range of sources (e.g. texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving information when possible.

- RST9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

- WHST.9-12.2 Write informative, explanatory texts, including the narration of historical events, scientific procedures, experiments, or technical processes.

WORLD LANGUAGES - N.A.

VISUAL/PERFORMING ARTS - N.A

APPLIED TECHNOLOGY -

- Whenever possible, highlight the basic physics models that appear in 21st century technological products. Explain and identify interdependent systems and their functions. Analyze a a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering(ergonomics).

BUSINESS EDUCATION -

- Is a product cost-effective to make?

GLOBAL AWARENESS -

- Discuss student applications from around the world who use their knowledge of physics ro solve pain-points in their lives. Examples obtained from local and national newspapers and the world-wide web.

Learning Plan / Pacing Guide

CP Physics/ Honors Physics (5 weeks)

Week #1

Fidget Spinners & Bottle Flipping - Constructing Mathematical Models (2 periods)

Linear & Non-Linear Relationships on Logger Pro (2 periods)

Developing a Linear Mathematical & Graphical Model (2 periods)

Honors Physics students will complete 4 stations for "Developing a Linear Mathematical & Graphical Model" / CP Physics will complete 3 stations.

Week #2

Developing a Linear Mathematical & Graphical Model - continued (1 period)

“Motion” Picture Walk (1 period)

“Describing Motion” Web Quest Part 1 – Physics Classroom (1 period)

PHET Moving Man Simulation / Logger Pro Graphs (2 periods)

Week #3

Tumble Buggy Lab – Logger Pro Position and Velocity vs Time Graphs / Linear Expressions (2 periods)

Tumble Buggy Challenge – 2-Meter Race and “Crashy Road” (2 periods)

Honors Physics students will have 1 opportunity to create a mathematical model for the Tumble Buggy Challenge and Race. CP Physics students will have 1 correction.

PBA – Tumble Buggy Graph Matching (2 periods)

Week #4

Motion Maps, Graphs and Vector Diagrams – AMTA Practice / Whiteboard (2 periods)

Quiz A – Motion Maps & Graphing Constant Velocity (1 period)

Honors Quiz A will be graded with a higher level of rigor - vector quantities (+/-), showing work, partial credit, etc.

Position vs Time and Velocity vs Time Graphs - AMTA Practice / Whiteboard (1 period)

Graph Matching w/ Vernier Motion Sensors and Logger Pro (2 periods)

Week #5

Quiz B - Position vs Time and Velocity vs Time Graphs (1 period)

PBA – PHET Simulation “Moving Man” Graph Matching (1 period)

Unit Test Review (2 periods)

Unit A Test (1 period)

Honors Unit A test will be graded with a higher level of rigor - vector quantities (+/-), showing work, partial credit, etc.

**Students in the Honors Physics Course will also complete activities from the "College Physics" by Etkina (Pearson 2014) online textbook which includes

“The Active Learning Guide” (ALG).**

**Students in the Honors Physics Course will also be assessed to a more rigorous standard. **

AP Physics 1 follows a separate set of standards set forth by the College Board.

This curriculum Unit would correlate with AP Unit 1 whose science practices are identified here:

Week #1: Graphing and Linearization

Week #2: Define Constant Velocity Motion with a laboratory experiment. Use Motion maps to categorize motion.

Week #3: Operations with vectors. Represent motion with data tables and a graph.

Week #4: Constant Velocity equation of motion. Find displacement from a velocity graph.

Week #5: Quiz, Lab Practicum, Unit Test.

*** Unit 2 - Constant Acceleration / Kinematics***

Content Area: **Science**
Course(s): **CP PHYSICS**
Time Period: **Marking Period 1**
Length: **5 weeks**
Status: **Published**

Standards and Phenomena

Science Standards

HE.9-12.2.1.12.EH.1	Recognize one's personal traits, strengths, and limitations and identify how to develop skills to support a healthy lifestyle.
HE.9-12.2.1.12.EH.3	Describe strategies to appropriately respond to stressors in a variety of situations (e.g., academics, relationships, shootings, death, car accidents, illness).
HE.9-12.2.1.12.SSH.4	Demonstrate strategies to prevent, manage, or resolve interpersonal conflicts without harming self or others (defining and understanding the laws of consent and dating violence).
SCI.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.
SCI.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.
SCI.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.
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.TL.1	Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.).
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).

Phenomena

Science and Engineering Practices

SCI.HS-PS1-5	Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Use a model to predict the relationships between systems or between components of a system.

Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Use mathematical representations of phenomena to describe explanations.

Disciplinary Core Ideas

Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed.

Newton's second law accurately predicts changes in the motion of macroscopic objects.

If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.

Crosscutting Concepts

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Much of science deals with constructing explanations of how things change and how they remain stable.

Transfer Goals

Based on their observations of a physical phenomenon, students will design an experiment to find a relationship between position and time of a cart moving down a nearly frictionless incline using the available measurement tools(stopwatches, meterstick and sonic ranger.) Students will use the Vernier graphical analysis software tool called LoggerPro to derive a linear mathematical model for the relationship. They will develop graphical, symbolic, and mathematical representations for the uniformly accelerating particle model. To introduce tangent lines to find instantaneous velocity concretely using the cart-on-incline lab as a race between the cart and the constant velocity buggy.

Concepts

Essential Questions

- How is accelerated motion different from constant velocity motion?
- Would you feel lighter or heavier in an elevator accelerating upward, downward?
- Can many problems be solved with graphs and motion maps instead of equations?
- What does it mean for an object to be in free fall?

Understandings

Motion is difficult to define, an object may be moving for one observer and stationary for another. This dilemma can be resolved by defining a reference frame.

The slope of the velocity vs. time graph is the acceleration.

Understand the difference between average velocity and instantaneous velocity and as the time interval approaches zero the average velocity approaches the instantaneous velocity.

When an object is speeding up, the velocity and the acceleration point in the same direction, when the object is slowing down, the acceleration and velocity point in opposite directions.

The area under the acceleration vs. time graph is Δv.

A problem solving strategy is to draw a velocity vs time graph. Displacement is found by calculating the area under this curve and acceleration is determined by finding the curve's rate of change. If a motion contains intervals of non-zero and zero accelerations, the appropriate model (CVPM or CAPM) can be applied to each interval.

Critical Knowledge and Skills

Knowledge

Students will know:

- How to define acceleration, including its vector nature.
- How to apply the model graphically, algebraically, and diagrammatically.
- How to use equations to analyze free fall motion once the acceleration due to gravity is obtained.
- That a cart racing down an inclined plane with a constant velocity buggy will have the same velocity as the buggy for only an instant in time.
- That the position vs time and the velocity vs time graphs look very different for an object accelerating vs. an object moving at a constant velocity.
- How to use the domain and kinematic properties, the classical kinematic equations can be developed.
- How to determine that free fall has a constant downward acceleration of magnitude g = 9.8 m/s2
- Area under the velocity vs time graph is displacement.

Skills

Students will be able to:

- Analyze area under v vs t graph to develop remaining mathematical kinematic expressions.
- Contrast graphs of objects undergoing constant velocity and constant acceleration. Distinguish between instantaneous and average velocity.
- Design an experiment, identify and classify variables, and make tentative qualitative predictions about the relationships between variables.
- Given a motion map, or a verbal description, or an equation, deduce the other motion representations.
- Given a position versus time graph or a velocity versus time graph, predict the missing graph and verify by creating matching graphs by walking appropriately toward or away from a motion sensor.
- Represent accelerated motion using velocity and acceleration vectors on a motion map.
- Use Graphical Analysis software to develop linear relationships.
- Use stack of kinematic curves: position vs time(slope of tangent = instantaneous velocity), velocity vs time(slope = acceleration, area under curve = change in position), acceleration vs time(area under curve = change in velocity) to describe accelerated motion.
- Obtain an accelerated model from laboratory data and create an operational definition of acceleration: $a = \Delta v/\Delta t$.
- Solve general kinematic problems with multiple accelerations using multiple representations.
- Solve vertical free-fall problems.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

Daily whiteboarding or discussion of homework problems from Modeling Curriculum, Active Learning Guide(ALG) or teacher designed scenarios all using Socratic Dialogue.

Assigned Homework.

"Describing Motion' Web Quest Part 2 – Physics Classroom

PHET "Moving Man" Simulation – Position vs Time & Velocity vs Time Graphs – Acceleration

Physics Classroom Concept Builders

Motion Maps, Graphs and Vector Diagrams for Acceleration – AMTA Practice / Whiteboard

Graph Stacks – Comparing Graphical Models for Acceleration – AMTA Practice / Whiteboard

Physics Classroom – The Acceleration "Rule of Thumb"

Motion Maps, Graphs and Vector Diagrams for Acceleration – AMTA Practice / Whiteboard

Accelerated Motion Graph Matching – Vernier Sensors w/ Logger Pro Graphs

Unit Test Review

Acceleration Graph Analysis

School Summative Assessment Plan

Unit Quizzes, Test and a major performance assessment. Including:

Quiz A: Graph Stacking

PBA - Accelerated Motion

Quiz B: Velocity vs Time Graphs

Unit 2 Test

Performance Assessment: Determine where to place cart on a ramp at a given angle, such that it crosses the finish line when relased from rest with a constant velocity cart(from a fixed distance.)

Primary Resources

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Technology Integration

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All assignments have been created in the student's native language.

Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

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- WHST.9-12.2 Write informative, explanatory texts, including the narration of historical events, scientific procedures, experiments, or technical processes.

WORLD LANGUAGES - N.A.

VISUAL/PERFORMING ARTS - N.A

APPLIED TECHNOLOGY -

- Whenever possible, highlight the basic physics models that appear in 21st century technological products. Explain and identify interdependent systems and their functions. Analyze a a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering(ergonomics).

GLOBAL AWARENESS -

- Discuss student applications from around the world who use their knowledge of physics ro solve pain-points in their lives. Examples obtained from local and national newspapers and the world-wide web.

BUSINESS EDUCATION -

- Is a product cost-effective to make?

Learning Plan / Pacing Guide

Week #1

"Describing Motion' Web Quest Part 2 – Physics Classroom (2 periods)

PHET "Moving Man" Simulation – Position vs Time & Velocity vs Time Graphs – Acceleration (2 periods)

Summary Questions for Moving Man differentiated (Honors vs CP level) by level of rigor for graph analyses.

Physics Classroom Concept Builders (1 period)

Week #2

Physics Classroom Concept Builders – continued (2 periods)

Motion Maps, Graphs and Vector Diagrams for Acceleration – AMTA Practice / Whiteboard (3 periods)

Quiz A – Graph Stacking (1 period)

Week #3

Graph Stacks – Comparing Graphical Models for Acceleration – AMTA Practice / Whiteboard (2 periods)

Physics Classroom – The Acceleration "Rule of Thumb" (1 period)

PBA – Accelerated Motion - Vernier Sensors w/ Logger Pro Graphs. (3 periods)

Honors students will work more independently during the PBA, while CP students can recieve limited teacher assistance to avoid compounding mistakes.

Week #4

Motion Maps, Graphs and Vector Diagrams for Acceleration – AMTA Practice / Whiteboard (2 periods)

Accelerated Motion Graph Matching – Vernier Sensors w/ Logger Pro Graphs (2 periods)

Physics Classroom Concept Builders (2 periods)

Week #5

Quiz B – Velocity vs Time Graphs (1 period)

Unit Test Review (2 periods)

Acceleration Graph Analysis (2 periods)

Unit B Test (1 period)

Unit B Test will be differentiated (Honors vs CP Level) in terms of grading rigor (partial and extra credit, showing work, vector quantities, etc.)

**Students in the Honors Physics Course will also complete activities from "Mastering physics" by Etkina (Pearson 2014) online textbook which includes

“The Active Learning Guide” (ALG).**

AP Physics 1 follows a separate set of standards set forth by the College Board.

This curriculum Unit would correlate with AP Unit 1 whose science practices are identified here:

Week #1: Motion at Constant Acceleration. Contrast Instantaneous velocity and average velocity. Determine velocity change from acceleration.

Week #2: Acceleration due to gravity. Explore free fall with a laboratory experiment.

Week #3: Determine the displacement of an object moving at constant acceleration graphically and with equations.

Week #4: Develop skills for analyzing situations involving 1-dimensional motion.

Week #5: Quiz, Lab Practicum, Unit Test.

*** Unit 3 - Dynamics***

Content Area: **Science**
Course(s): **CP PHYSICS**
Time Period: **Marking Period 2**
Length: **7 weeks**
Status: **Published**

Standards and Phenomena

Science Standards

HE.9-12.2.1.12.EH.1	Recognize one's personal traits, strengths, and limitations and identify how to develop skills to support a healthy lifestyle.
HE.9-12.2.1.12.SSH.4	Demonstrate strategies to prevent, manage, or resolve interpersonal conflicts without harming self or others (defining and understanding the laws of consent and dating violence).
HE.9-12.2.3.12.PS.8	Develop strategies to communicate effectively, safely, and with empathy when using digital devices in a variety of situations (e.g., cyberbullying, sexting).
SCI.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.
SCI.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.
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.TL.1	Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Phenomena

Science and Engineering Practices

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Use a model to predict the relationships between systems or between components of a system.

Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Use mathematical representations of phenomena to describe explanations.

Disciplinary Core Ideas

Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects.

Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.

Newton's second law accurately predicts changes in the motion of macroscopic objects.

If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.

Crosscutting Concepts

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

The total amount of energy and matter in closed systems is conserved.

Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Much of science deals with constructing explanations of how things change and how they remain stable.

Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

Systems can be designed to cause a desired effect.

Transfer Goals

Newton's 2nd law of motion describes what causes a velocity to change direction and/or magnitude – an unbalanced force. What is the mathematical and physical model for friction? Applications involving static and kinetic friction are explored.

In this unit, students are introduced to the first half of Newton's Modeling Cycle: a) from motions(read: changes in velocity) infer forces b.) from forces deduce motions. Students need to see that the constant velocity condition does not require an explanation; that changes in velocity require an explanation between an agent and an object. We quantify this interaction by the concept of force.

Understand the Law of Inertia and Newton's 3rdLaw and its application to static equilibrium problems.

Concepts

Essential Questions

- How does a force affect motion?
- Can an object continue to move if no forces act on it?
- How can a broom be used to make a moving bowling ball roll in a circle?
- Your little brother and you stand facing each other on the skating rink. You push off each other. Who experiences the greater force? Who accelerates more?
- A circus performer hangs from a rope. She then begins to climb upwards. As she begins to climb, is the

tension in the rope greater than, equal to or less than when she was stationary?

- Is air resistance always undesirable? What are some applications of air resistance?
- You have a choice of pushing or pulling a sled at an angle to move it at a constant velocity. Friction is present. Should you push or pull the sled?

Understandings

The acceleration of the center of mass of a system is related to the net external force exerted on the system and the total mass.

At the macroscopic level, forces can be categorized as either long-range(action at a distance) forces or contact forces.

Critical Knowledge and Skills

Knowledge

Students will know:

- The motion of an object changes only when a net force is applied.
- The magnitude of acceleration of an object depends directly on the strength of the net force, and inversely on the mass of the object. This relationship (a=Fnet/m) is independent of the nature of the force.
- Forces have magnitude and direction.
- Forces can be added resulting in a net force which is the sum of all the forces acting on the object
- An object at rest will remain at rest unless acted on by an unbalanced force.
- An object in motion at constant velocity will continue at the same velocity unless acted on by an unbalanced force.
- How to distinguish between force, mass, inertia and weight.
- How to differetiate between static and kinetic friction.

Skills

Students will be able to:

- Explain a variety of phenomenon using Newton's First Law.
- Use vector graphical addition or components to reason and make calculations about static equilibrium. $\sum F = 0$
- Use the cause and effect form of Newton's Second Law: $a = \Sigma F/m$
- Be able to draw and label free body diagrams, as well as calculate the net force(ΣF) from them
- Reason about the phenomenon of the normal force
- Calculate the weight and apparent weight of an object.
- Quantify and explain the force exerted on an object that is on a frictionless or non-frictionless ramp.
- Differentiate between static and kinetic friction.
- State and correctly apply Newton's Third Law.
- Successfully combine the concepts of Newton's Laws with those of Kinematics.
- Solve vertical free-fall problems.
- Solve 2D horizontal projectile motion problems.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

Daily whiteboarding or discussion of homework problems from Modeling Curriculum, Active Learning Guide(ALG) or teacher designed scenarios all using Socratic Dialogue.

Assigned Homework.

Quizzes.

"What is a Force?" Web Quest – Physics Classroom

Representing Forces – Free Body Diagrams

Physics Classroom Concept Builders

Qualitative Free Body Diagrams – AMTA Practice / Whiteboard

Physics Classroom "Rocket Sled" Interactive

Physics Classroom Skill Builders

Force Diagrams & Component forces – AMTA Practice / Whiteboard

"Physics Classroom" Video – Newton's First Law

Classroom Curling

“Newton’s First Law” Web Quest

Newton’s First Law – The Elevator Ride

Quantitative Free Body Diagrams – AMTA Practice / Whiteboard

PHET Simulation – Forces and Motion

"Projectile Motion" Web Quest - The Physics Classroom

Physics Classrom Interactive - Hit the Target

Physics Classrom - Concept Builders

School Summative Assessment Plan

Unit Test and a major performance assessment. These would include:

Quiz A – Qualitative Force Diagrams

Quiz B - Quantitative Free Body Diagrams

Quiz C - Horizontally Launched Projectiles

PBA – Qualitative Free Body Diagrams

Unit 3 (Dynamics) Test

Performance Assessment:(1) Determine the acceleration of a Fan Cart.(2) Place a cart filled with assorted masses on an inclined ramp. Run a string from the cart up the ramp to its top. Loop it over a frictionless pulley, and attach a hanging mass so the cart is at rest on the ramp. Cover this hanging mass. Students need to predict the value of the covered hanging mass.

Primary Resources

AMTA Modeling Physics Program(2013)

http://modelinginstruction.org/

Rutgers Physics Unified Mathematics(PUM) online resources

http://pum.rutgers.edu/

Honors Physics:

College Physics by Etkina Pearson 2014 online textbook which includes

“The Active Learning Guide” (ALG)

Supplementary Resources

Phet Simulations
Vernier Ultrasonic Sensors(Motion, Force, Photogates)
Teacher designed powerpoints and/or Google Docs
TIPERs Sensemaking Tasks for Introductory Physics Pearson 2015
Direct Measurement Videos serc.carleton.edu/dmvideos/index.html
The Universe and More http://theuniverseandmore.com

The Physics Classroom http://www.physicsclassroom.com/
Google Docs on Teachers Website or Google Classroom

Technology Integration and Differentiated Instruction

Technology Integration

Google Products

Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)

GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

One to One Student's laptop

All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

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Additional Support Videos

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be viewed either in the classroom on the Smart Board or through links created on the Google Classroom.

The Physics Circus - a video collection produced through the University of Minnesota Physics Department Faculty.

Khan Academy

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

All assignments have been created in the student's native language.

Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH -

- MP1 Make sense of problems and persevere in solving them. MP 2. Reason Abstractly and quantitatively. MP4 Model with Mathematics. MP5 Use appropriate tools strategically.

ELA -

- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a problem or solve a problem.

- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text verofying the data when possible, and corroborating or challenging conclusions with other sources of information.

- RST.11_12.9 Synthesize information from a range of sources (e.g. texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving information when possible.

- RST9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

- WHST.9-12.2 Write informative, explanatory texts, including the narration of historical events, scientific procedures, experiments, or technical processes.

WORLD LANGUAGES -

- Students may encounter specific words defining physics whose origin derives from the physicist's home and native language.

VISUAL/PERFORMING ARTS -

- Students can express their understanding of physics in song or pictorially in cartoons. It's all about the story.

APPLIED TECHNOLOGY -

- Whenever possible, highlight the basic physics models that appear in 21st century technological products. Explain and identify interdependent systems and their functions. Analyze a a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering(ergonomics).

BUSINESS EDUCATION -

- Is a product cost-effective to make?

GLOBAL AWARENESS -

- Discuss student applications from around the world who use their knowledge of physics ro solve pain-points in their lives. Examples obtained from local and national newspapers and the world-wide web.

Learning Plan / Pacing Guide

Week #1

“What is a Force?” Web Quest Part 1 – Physics Classroom (2 periods)

Representing Forces – Free Body Diagrams (1 period)

Physics Classroom Concept Builders (2 periods)

Qualitative Free Body Diagrams – AMTA Practice / Whiteboard (1 period)

Honors Physics - will complete "Mastering Physics" Activity #1 - Pearson On-Line Textbook

Week #2

Qualitative Free Body Diagrams – AMTA Practice / Whiteboard – continued (1 period)

Physics Classroom “Rocket Sled” Interactive (1 period)

Physics Classroom Skill Builders (2 periods)

Force Diagrams & Component forces – AMTA Practice / Whiteboard – continued (1 period)

Quiz A – Qualitative Force Diagrams (1 period)

Week #3

“Physics Classroom” Video – Newton’s First Law (1 period)

Classroom Curling (2 periods)

“Newton’s First Law” Web Quest (2 periods)

Newton’s First Law – The Elevator Ride (1 period)

Week #4

Newton’s First Law – The Elevator Ride - continued (1 period)

Quantitative Free Body Diagrams – AMTA Practice / Whiteboard (2 periods)

Quiz B - Quantitative Free Body Diagrams (1 period)

PHET Simulation – Forces and Motion – Basics (2 periods)

Week #5

FBD Unit Test Review (2 periods)

PBA – Qualitative Free Body Diagrams (3 periods)

Unit 3 (Dynamics)Test (1 period)

Week #6

"Projectile Motion" Web Quest - The Physics Classroom (1 period)

Free Fall Kinematics & Horizontally Launched Projectiles – AMTA Practice / Whiteboard (2 periods)

Quiz #3 - Horizontally Launched Projectiles (1 period)

Physics Classrom Interactive - Hit the Target (1 period)

Physics Classrom - Concept Builders (1 period)

Week #7

Projectile Motion Problems – AMTA Practice / Whiteboard (2 periods)

PhET - Projectile Motion Simulation (2 periods)

PBA - Horizontally-Launched Projectile Investigation (2 periods)

**Students in the Honors Physics Course will also complete activities from the "College Physics" by Etkina (Pearson 2014) online textbook which includes

“The Active Learning Guide” (ALG).**

**Students in the Honors Physics Course will also be assessed to a more rigorous standard. **

AP Physics 1 follows a separate set of standards set forth by the College Board.

This curriculum Unit would correlate with AP Unit 2 whose science practices are identified here:

Week #1: Develop Vector Graphical Addition(VGA) Method to add and subtract forces. Introduce system concept. Represent an interaction as a force. Draw force diagrams.

Week #2: Test possible relationships between force and motion. Explore Inertial reference frames and Newton's first law. Employ motion diagrams.

Week #3: Define mass and discover Newton's second law through experiments. Acceleration is the sum of the forces divided by the system mass.

Week #4: Use VGA to solve two-dimensional force problems. Define the gravitational force law.

Week #5: Develop skills for applying Newton's second law for one-dimensional processes.

Week #6: Investigate how forces come in pairs: Newton's third law. Application problem solving with all Newton's laws.

Week #7: Develop models for static and kinetic friction. Starting and stopping a car.

Week #8: Apply Newton's laws in solving processes involving inclines, Atwood's Machine.

Week #9: Qualitative and Quantitative analysis of projectile motion.

Week #10: Quiz, Lab Practicum, Unit Test.

*** Unit 4 - Circular & Planetary Motion**

Content Area:	**Science**
Course(s):	**CP PHYSICS**
Time Period:	**Marking Period 2**
Length:	**5 weeks**
Status:	**Published**

Standards and Phenomena

Science Standards

HE.9-12.2.1.12.EH.1	Recognize one's personal traits, strengths, and limitations and identify how to develop skills to support a healthy lifestyle.
HE.9-12.2.1.12.SSH.4	Demonstrate strategies to prevent, manage, or resolve interpersonal conflicts without harming self or others (defining and understanding the laws of consent and dating violence).
SCI.HS-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
SCI.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.
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).

Phenomena

Science and Engineering Practices

SCI.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.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Create a computational model or simulation of a phenomenon, designed device, process, or system.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Use a model to predict the relationships between systems or between components of a system.

Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Use mathematical representations of phenomena to describe explanations.

Disciplinary Core Ideas

If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.

Newton's second law accurately predicts changes in the motion of macroscopic objects.

Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes.

Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.

Crosscutting Concepts

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

The total amount of energy and matter in closed systems is conserved.

Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

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Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

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When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

Systems can be designed to cause a desired effect.

Transfer Goals

In this unit of study, students use mathematical and computational thinking to examine the processes governing the workings of the solar system and universe. While doing so they plan and conduct investigations and apply scientific ideas to make sense of Newton's law of gravitation to describe and predict the gravitational forces between objects.

Concepts

Essential Questions

- How do amusement park rides(like roller coasters or the Gravitron) use the principles of circular motion?
- How is it possible to spin a bucket of water over your head without the water falling out?
- How was it possible for NASA to intentionally fly into Comet Tempel 1?
- Is a force necessary for a system or object to undergo uniform circular motion?
- What keeps planets moving around the Sun but stops them from crashing into the sun?

Understandings

The gravitational field at the location of an object's mass causes a gravitational force.

A net force is necessry for an object to change its motion.

A force perpendicular to an objects's velocity always causes a change in its direction of motion.

Critical Knowledge and Skills

Knowledge

Students will know:

- the physical and mathematical aspects of uniform circular motion.
- the difference between angular speed versus tangential speed
- how to solve problems that involve involve objects moving in vertical circles
- the significance of the gravitational constant
- a net force is necessary for an object to move in a circle
- the magnitude of the net force is not constant for an object moving in a vertical circle

Skills

Students will be able to:

- Describe why objects move in a circular path and what characteristics this motion has.
- Analyze the motion of an object (circle, constant speed) to show that the sum of the force points towards the center.
- Draw velocity & acceleration vectors for an object for an object moving in a circle at constant speed.
- Use vector addition vOld + Δ v = VNew to account for changes in velocity for an object moving at constant speed in a circle.
- Calculate period, frequency, velocity, net force, and acceleration for an object in uniform circular motion.
- Explain what happens if the net force was no longer acting on the object.
- Represent circular motion in various ways: pictures, vector diagrams, words, and equations.
- Apply Newton's Law of Universal Gravitation to describe celestial mechanics and dynamics.
- Discuss Kepler's Three Laws of Planetary Motion.
- Calculate the speed of a geostationary satellite.
- Describe the difference between period and frequency and use to calculate velocity if moving in

uniform circular motion..

- Describe how the force exerted on an object changes as it moves in a vertical circle.
- Find the period or distance away from a center object of another object in orbit.
- Apply knowledge of circular motion to explain applications like why a banked curve is used as a highway off ramp.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

Daily whiteboarding or discussion of homework problems from Modeling Curriculum, Active Learning Guide(ALG) or teacher designed scenarios all using Socratic Dialogue.

Assigned Homework.

Quizzes.

“Centripetal Motion Web Quest – Physics Classroom

The Centripetal Force Requirement

Physics Classroom Concept Builders

Uniform Circular Motion Interactive – The Physics Classroom

Concept Builders – The Physics Classroom

Gravity and Orbits - PHET Simulation

Gravitation Interactive - The Physics Classroom

School Summative Assessment Plan

Unit Test and a major performance assessment.

These would include:

Quiz #1 – Qualitative Circular Motion

PBA – Circular and Satellite Motion Interactive

Quiz #2 - Orbital Motion

PBA - Uniform Circular Motion Investigation

Unit 4 Test

Performance Assessment: Predict the period of a "flying pig" toy.

Primary Resources

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Technology Integration and Differentiated Instruction

Technology Integration

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Additional Support Videos

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Topic. There are more additional videos provided for each and can be viewed either in the classroom on the Smart Board or through links created on the Google Classroom.

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Khan Academy

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

All assignments have been created in the student’s native language.

Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH -

- MP1 Make sense of problems and persevere in solving them. MP 2. Reason Abstractly and quantitatively. MP4 Model with Mathematics. MP5 Use appropriate tools strategically.

ELA -

- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a problem or solve a problem.

- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text verofying the data when possible, and corroborating or challenging conclusions with other sources of information.

- RST.11_12.9 Synthesize information from a range of sources (e.g. texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving information when possible.

- RST9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

- WHST.9-12.2 Write informative, explanatory texts, including the narration of historical events, scientific procedures, experiments, or technical processes.

WORLD LANGUAGES -

- Students may encounter specific words defining physics whose origin derives from the physicist's home and native language.

VISUAL/PERFORMING ARTS -

- Students can express their understanding of physics in song or pictorially in cartoons. It's all about the story.

APPLIED TECHNOLOGY -

- Whenever possible, highlight the basic physics models that appear in 21st century technological products. Explain and identify interdependent systems and their functions. Analyze a a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering(ergonomics).

BUSINESS EDUCATION -

- Is a product cost-effective to make?

GLOBAL AWARENESS -

- Discuss student applications from around the world who use their knowledge of physics ro solve pain-points in their lives. Examples obtained from local and national newspapers and the world-wide web.

Learning Plan / Pacing Guide

CP Circular Motion:

Week #1

"Centripetal Motion Web Quest – Physics Classroom (2 periods)

The Centripetal Force Requirement (1 period)

Physics Classroom Concept Builders (2 periods)

Radial Net Force & Circular Motion – AMTA Practice / Whiteboard – (1 period)

Week #2

Radial Net Force & Circular Motion – AMTA Practice / Whiteboard – continued (1 period)

Uniform Circular Motion Interactive – The Physics Classroom (2 periods)

Qualitative Radial Net Force – AMTA Practice / Whiteboard – (1 period)

Identify Centripetal Forces (1 period)

Week #3

Circular Motion (Quantitative) – AMTA Practice / Whiteboard – (2 periods)

Quiz #1 – Qualitative Circular Motion (1 period)

PBA - Uniform Circular Motion Investigation (2 periods)

Concept Builders – The Physics Classroom (1 period)

Week #4

Orbital Motion – AMTA Practice / Whiteboard – (2 periods)

Gravity and Orbits - PHET Simulation (2 periods)

Gravitation Interactive – The Physics Classroom (2 periods)

Week #5

PBA – Circular and Satellite Motion Interactive (2 periods)

Quiz #2 - Orbital Motion (1 period)

Unit Test Review (2 periods)

Unit 4 Test (1 period)

**Students in the Honors Physics Course will also complete activities from the "College Physics" by Etkina (Pearson 2014) online textbook which includes

“The Active Learning Guide” (ALG).**

**Students in the Honors Physics Course will also be assessed to a more rigorous standard. **

AP Circular Motion:

AP Physics 1 follows a separate set of standards set forth by the College Board.

This curriculum Unit would correlate with AP Unit 3 whose science practices are identified here:

Week #1: Qualitative and Quantitative Analysis of Circular Motion. Use VGA of velocity vectors to determine the acceleration. Show how circular acceleration depends on speed and radius. Define the period.

Week #2: Develop skills for analyzing processes involving circular motion i.e toy airplane, exiting from a highway on a ramp, riding a rotor amusement park ride.

Week #3: More problem-solving. Examine conceptual difficulties with circular motion like a passenger in a taxi making a high-speed turn.

Week #4: The law of universal gravitation dependence on distance and mass. Newton's third law and the gravitational force between a tennis ball and mother earth.

Week #5: Kepler's Laws. Limitations of the law of universal gravitation. Are astronauts weightless?

Week #6: Circular motion problem-solving.

Week #7: Quiz, Lab Practicum, Unit Test.

AP Rotational Motion:

AP Physics 1 follows a separate set of standards set forth by the College Board.

This curriculum Unit would correlate with AP Unit 7 whose science practices are identified here:

Week#1: Rotational kinematics - define the rotational position, angular velocity, and angular acceleration. Relate translational and rotational quantities.

Week#2: Rotational Motion at constant acceleration. Rotational inertia(moment of inertia) and the net torque affect rotational acceleration.

Week#3: Newton's second rotational motion law applies to rigid bodies. How to calculate rotational inertia. Atwood's machine revisited. Additional problem-solving.

Week#4: Rotational momentum is constant for an isolated system. Explore the vector nature of torque, rotational velocity, and rotational momentum.

Week#5: Rotational Kinetic Energy. Additional practice solving rotational problems using kinematics, conservation of angular momentum, or conservation of energy.

Week#6: Quiz, Lab Practicum, Unit test.

*** Unit 5: Momentum***

Content Area: **Science**
Course(s): **CP PHYSICS**
Time Period: **Marking Period 2**
Length: **3 weeks**
Status: **Published**

Standards and Phenomena

Science Standards

HE.9-12.2.1.12.EH.1	Recognize one’s personal traits, strengths, and limitations and identify how to develop skills to support a healthy lifestyle.
HE.9-12.2.1.12.EH.3	Describe strategies to appropriately respond to stressors in a variety of situations (e.g., academics, relationships, shootings, death, car accidents, illness).
HE.9-12.2.1.12.SSH.4	Demonstrate strategies to prevent, manage, or resolve interpersonal conflicts without harming self or others (defining and understanding the laws of consent and dating violence).
SCI.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.
SCI.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.
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.TL.1	Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.).
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).

Phenomena

Science and Engineering Practices

SCI.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.
	Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Create a computational model or simulation of a phenomenon, designed device, process, or system.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Use a model to predict the relationships between systems or between components of a system.

Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Use mathematical representations of phenomena to describe explanations.

Disciplinary Core Ideas

Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object.

If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.

Crosscutting Concepts

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

The total amount of energy and matter in closed systems is conserved.

Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Much of science deals with constructing explanations of how things change and how they remain stable.

Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

Systems can be designed to cause a desired effect.

Transfer Goals

Momentum is defined as "the quantity of motion of a moving body, measured as a product of its mass and velocity".

In this unit, students will learn how to quantify momentum, based on the definition provided above. They will further explore that during a collision, objects can interact with each other and momentum can be transferred from one object to another as a result of a collision. Students will attempt to prove the law of conservation of momentum - the total momentum within a defined system is constant before and after the collision, provided no external forces act on the system.

Finally, students will investigate the relationship between momentum and impulse. Specifically, students will incorporate the momentum - impulse theorem into designing and constructing a safety cage to survive progressively more violent collisions.

Concepts

Essential Questions

- How is the physics definition of "momentum" different from our everyday meaning of this wOrd?
- What makes one collision different from another?
- What makes certain cars safer than others?
- How is Newton's Cradle explained?
- What happens to the inherent energy in objects when they collide?
- Why am I safer in a car crash if I am in a big vehicle, compared to a smaller one?

Understandings

Momentum is a word that we hear used colloquially in everyday life. We are often told that sports teams and political candidates have "a lot of momentum". In this context, the speaker usually means to imply that the team or candidate has had a lot of recent success and that it would be difficult for an opponent to change their trajectory.

This is also the essence of the meaning in physics, though in physics we need to be much more precise.

Momentum is a measurement of mass in motion: how much mass is in how much motion. It is usually given the symbol \mathbf{p}p.

The useful thing about momentum is its relationship to force. Impulse is a term that quantifies the overall effect of a force acting over time. It is conventionally given the symbol J and expressed in Newton-seconds.

One of the reasons why impulse is important and useful is that in the real world, forces are often not constant. Forces due to things like people and engines tend to build up from zero over time and may vary depending on many factors. Working out the overall effect of all these forces directly would be quite difficult.

When we calculate impulse, we are multiplying force by time. This is equivalent to finding the area under a force-time curve. This is useful because the area can just as easily be found for a complicated shape—variable force—as for a simple rectangle—constant force. It is only the overall net impulse that matters for understanding the motion of an object following an impulse

Critical Knowledge and Skills

Knowledge

Students will know:

- How to use the mathematical model for momentum to calculate an object's "quantity of motion".
- The difference between 3 types of collisions - elastic collisions, inelastic collisions and explosive collisions.
- How impulse and momentum change are related.
- Collisions often result in momentum change.

Skills

Students will be able to:

- Use the Law of Conservation of Momentum to predit momentum changes to objects within a defined system.
- How the stopping force during a collision has an effect on the stopping time.
- Incorporate the principles of the momentum - impulse theorem into designing and building a safety cage that will allow an uncooked egg to survive progressively more violent collisions.
- Assess the effectiveness of their safety cage design, as well as those of fellow classmates.
- Propose design changes / improvements to safety cage design that will result in more "crash-worthy" design.
- Distinguish between a system's internal and external interactions.
- Express Newton's Second Law in terms of momentum.
- Use force versus time graphs to calculate the impulse delivered by a variable force.
- Use momentum bar charts to qualitatively analyze momentum scenarios in a system(before, after, and during impulse)

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

Daily whiteboarding or discussion of homework problems from Modeling Curriculum, Active Learning Guide(ALG) or teacher designed scenarios all using Socratic Dialogue.

Assigned Homework.

Quizzes.

Collision Carts Interactive – Physics Classroom

IIHS - "Understanding Car Crashes: It's Basic Physics"

Investigation – Conservation of Momentum

PHET Simulation – Collisions

Physics Classroom Skill Builders

“Momentum and Impulse” - Physics Classroom

“Egg Crasher” Challenge (3 periods)

Unit Test Review (2 periods)

School Summative Assessment Plan

Unit Test and a major performance assessment.

These would include:

Collisions Quiz

PBA – Conservation of Momentum

Unit 5 (Momentum) Test

Performance Assessment: Two carts of different mass undergo an "explosion". Place them on a frictionless track such that they both hit the endstops simultaneously.

Primary Resources

AMTA Modeling Physics Program(2013)

http://modelinginstruction.org/

Rutgers Physics Unified Mathematics(PUM) online resources http://pum.rutgers.edu/

Honors Physics:

College Physics by Etkina Pearson 2014 online textbook which includes

"The Active Learning Guide" (ALG)

Supplementary Resources

- Phet Simulations
- Vernier Ultrasonic Sensors(Motion, Force, Photogates)
- Teacher designed powerpoints and/or Google Docs
- TIPERs Sensemaking Tasks for Introductory Physics Pearson 2015
- Direct Measurement Videos serc.carleton.edu/dmvideos/index.html
- The Universe and More http://theuniverseandmore.com
- The Physics Classroom http://www.physicsclassroom.com/
- Google Docs on Teachers Website or Google Classroom

Technology Integration and Differentiated Instruction

Technology Integration

Google Products

Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)

GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

One to One Student's laptop

All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

PhET - Founded in 2002 by Nobel Laureate Carl Wieman, the PhET Interactive Simulations project at the University of Colorado Boulder creates free interactive math and science simulations. PhET sims are based on extensive education research and engage students through an intuitive, game-like environment where students learn through exploration and discovery.

The Physics Classroom - The Physics Classroom is an online, free to use physics website developed primarily for beginning physics students and their teachers. The website features a variety of sections intended to support both teachers and students in the tasks of learning and teaching physics.

Additional Support Videos

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be viewed either in the classroom on the Smart Board or through links created on the Google Classroom.

The Physics Circus - a video collection produced through the University of Minnesota Physics Department Faculty.

Khan Academy

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❑ All assignments have been created in the student’s native language.

❑ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❑ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❑ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH -

- MP1 Make sense of problems and persevere in solving them. MP 2. Reason Abstractly and quantitatively. MP4 Model with Mathematics. MP5 Use appropriate tools strategically.

ELA -

- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a problem or solve a problem.

- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text verofying the data when possible, and corroborating or challenging conclusions with other sources of information.

- RST.11_12.9 Synthesize information from a range of sources (e.g. texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving information when possible.

- RST9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

- WHST.9-12.2 Write informative, explanatory texts, including the narration of historical events, scientific procedures, experiments, or technical processes.

WORLD LANGUAGES -

- Students may encounter specific words defining physics whose origin derives from the physicist's home and native language.

VISUAL/PERFORMING ARTS -

- Students can express their understanding of physics in song or pictorially in cartoons. It's all about the story.

APPLIED TECHNOLOGY -

- Whenever possible, highlight the basic physics models that appear in 21st century technological products. Explain and identify interdependent systems and their functions. Analyze a a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering(ergonomics).

BUSINESS EDUCATION -

- Is a product cost-effective to make?

GLOBAL AWARENESS -

- Discuss student applications from around the world who use their knowledge of physics ro solve pain-points in their lives. Examples obtained from local and national newspapers and the world-wide web.

Learning Plan / Pacing Guide

Week #1

Collision Carts Interactive – Physics Classroom (2 periods)

IIHS - "Understanding Car Crashes: It's Basic Physics" (1 period)

Investigation – Conservation of Momentum (3 periods)

Week #2

PHET Simulation – Collisions (1 period)

Physics Classroom Skill Builders (2 periods)

“Momentum and Impulse” - Physics Classroom (1 period)

PBA – Conservation of Momentum (2 periods)

Week #3

“Egg Crasher” Challenge (3 periods)

Unit Test Review (2 periods)

Unit 5 (Momentum) Test (1 period)

**Students in the Honors Physics Course will also complete activities from the "College Physics" by Etkina (Pearson 2014) online textbook which includes

“The Active Learning Guide” (ALG).**

**Students in the Honors Physics Course will also be assessed to a more rigorous standard. **

AP Physics 1 follows a separate set of standards set forth by the College Board.

This curriculum Unit would correlate with AP Unit 5 whose science practices are identified here:

Week#1: What happens if an object's mass changes during a process? Investigate Linear Momentum of two masses using video analysis.

Week#2: What is the momentum of a system? Organize the system through bar graphs.

Week#3: If a system's momentum is not constant, and impulse has occurred. Calculate the impulse graphically.

Week#4: Define and apply the generalized impulse-momentum principle.

Week#5: Develop skills for analyzing problems using impulse and momentum. Use VGA to solve collisions in two dimensions.

Week#6: Quiz, Lab Practicum, Unit Test.

*** Unit 6 - Energy***

Content Area: **Science**
Course(s): **CP PHYSICS**
Time Period: **Marking Period 3**
Length: **7 weeks**
Status: **Published**

Standards and Phenomena

Science Standards

HE.9-12.2.1.12.EH.1	Recognize one's personal traits, strengths, and limitations and identify how to develop skills to support a healthy lifestyle.
HE.9-12.2.1.12.EH.3	Describe strategies to appropriately respond to stressors in a variety of situations (e.g., academics, relationships, shootings, death, car accidents, illness).
HE.9-12.2.1.12.SSH.4	Demonstrate strategies to prevent, manage, or resolve interpersonal conflicts without harming self or others (defining and understanding the laws of consent and dating violence).
SCI.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.
SCI.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.
SCI.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).
SCI.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.
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
	Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
	Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.
	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and

developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).

Phenomena

Science and Engineering Practices

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Use mathematical representations of phenomena to describe explanations.

Use a model to predict the relationships between systems or between components of a system.

Create a computational model or simulation of a phenomenon, designed device, process, or system.

Disciplinary Core Ideas

Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.

The availability of energy limits what can occur in any system.

At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.

Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.

These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.

Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.

Crosscutting Concepts

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

The total amount of energy and matter in closed systems is conserved.

Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Systems can be designed to cause a desired effect.

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Much of science deals with constructing explanations of how things change and how they remain stable.

Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

Patterns

Transfer Goals

In this unit of study, students develop and use models, plan and carry out investigations, use computational thinking and design solutions as they make sense of the disciplinary core idea. The disciplinary core idea of

Energy is broken down into sub core ideas: definitions of energy, conservation of energy and energy transfer, and the relationship between energy and forces. Energy is understood as a quantitative property of a system that depends on the motion and interactions of matter, and the total change of energy in any system is equal to the total energy transferred into and out of the system. Students also demonstrate their understanding of engineering principles when they design, build, and refine devices associated with the conversion of energy.

Concepts

Essential Questions

- A pendulum will return almost exactly to the point from which it was released.
- A roller coaster(starting from rest) can climb no higher than the height it was originally released.
- How can systems interact to transfer energy?
- How can work change the total energy of a system?
- How does the rate of energy transfer affect a systems total energy?
- How does the system of choice affect the subsequent analysis of energy transfers?
- What are the forms of mechanical energy?
- What does it mean for a quantity to be conserved?
- What is energy?
- Why is it impossible to create a perpetual motion machine?

Understandings

Energy is a substance-like quantity that can produce change and is conserved. Energy can be transferred to a system only if an object outside the system "works" on the system. Agents or objects within the system can not do work on the system.

Critical Knowledge and Skills

Knowledge

Students will know:

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles).
- In some cases, the relative position energy can be thought of as stored in fields (which mediate interactions between particles).
- Energy can be transferred to and from a system through work.
- Interactions with other systems can change the total energy of a system.
- Radiation is a phenomenon in which energy stored in fields moves across spaces.
- The energy of a system is conserved.
- The mechanical energy of a system is defined as the sum of the kinetic and potential energy which is stored energy due to position.
- Only objects outside a system can do work on a system.

Skills

Students will be able to:

- Define and apply the concept of work done by a force exerted in any direction relative to an object's displacement.
- Use force vs position graphs to calculate the work done by a variable force.
- Explain the significance of positive, negative, and zero work in terms of energy transfer.
- Distinguish bewteen conservative and non-conservative forces.
- Describe and use the ideas of gravitational and elastic potential energy.
- Apply the Law of Conservation of Energy to non-isolated systems.
- Explain and quantify the transformation of energy within a variety of isolated systems.
- Apply the Law of Conservation of Energy to non-isolated systems.
- Calculate the power produced by a particular object, or the work done by an engine.
- Use multiple representations like bar graphs to diagram energy tranfer and transformations within a system.
- Discuss the various forms of energy including thermal, chemical, and nuclear energies.
- Use knowledge of energy transfer and transformation to reason about physical scenarios that are difficult to analyze with Newton's Laws and Kinematics.
- Analyze the transformation of Kinetic Energy to Elastic Potential Energy and Thermal Energy during an elastic and inelastic collision.
- Combine the laws of Conservation of Momentum and Conservation of Energy to mathematically model elastic and inelastic collisions.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

Daily whiteboarding or discussion of homework problems from Modeling Curriculum, Active Learning Guide(ALG) or teacher designed scenarios all using Socratic Dialogue.

Assigned Homework.

Quizzes.

"Types of Energy" Web Quest

PHET – Energy Skate Park Simulation

Qualitative Energy Analysis (Pie Charts) – AMTA Practice / Whiteboard

Physics Classroom Concept Builders – Name That Energy

PHET – Energy Forms and Changes

Qualitative Energy Storage & Conservation with Bar Graphs – AMTA Practice / Whiteboard

"Work & Energy" and "Stopping Distance" – Physics Classroom Interactives

Quantifying Energy - Equations

Quantitative Energy Storage & Conservation (LOL Charts) – AMTA Practice / Whiteboard

“Chart That Motion” – Physics Classroom Interactives

Physics Classroom Concept Builders – “What Up (and Down) with KE and PE?” and “Energy Ranking Tasks”

Quantitative Energy Calculations & Conservation (LOL Charts) – AMTA Practice / Whiteboard

Egg Lander Challenge

Physics Classroom Concept Builders – “Work”

Energy Transfer and Power – AMTA Practice / Whiteboard

PHET Simulations – “Hooke’s Law” and “Masses and Springs”

Physics Classroom Interactive – Vibrating Mass on a Spring”

Solar Oven Challenge

School Summative Assessment Plan

Unit Test and a major performance assessment.

These would include:

Quiz A – Pie Graph and “LOL” Charts – Qualitative Representations

PBA – Quantitative Energy Transfer Analysis

Quiz B – Quantitative Energy Conservation

PBA – Types of Energy Independent Research - Google Slides

Quiz C – Energy Transfer and Power

Unit 6 (Energy) Test

Performance Assessment: Bungee Jump, Cart traveling down an inclined ramp on a lab table should be engineered to hit a target on the floor.

Primary Resources

AMTA Modeling Physics Program(2013)

http://modelinginstruction.org/

Rutgers Physics Unified Mathematics(PUM) online resources

http://pum.rutgers.edu/

Honors Physics:

College Physics by Etkina Pearson 2014 online textbook which includes

“The Active Learning Guide” (ALG)

Supplementary Resources

Phet Simulations
Vernier Ultrasonic Sensors(Motion, Force, Photogates)
Teacher designed powerpoints and/or Google Docs
TIPERs Sensemaking Tasks for Introductory Physics Pearson 2015
Direct Measurement Videos serc.carleton.edu/dmvideos/index.html
The Universe and More http://theuniverseandmore.com

The Physics Classroom http://www.physicsclassroom.com/
Google Docs on Teachers Website or Google Classroom

Technology Integration and Differentiated Instruction

Technology Integration

Google Products

Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)

GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

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All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

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Khan Academy

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Gifted Students (N.J.A.C.6A:8-3.1)

Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

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Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

All assignments have been created in the student's native language.

Work with ELL Teacher to allow for all assignments to be completed with extra time.

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Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH -

- MP1 Make sense of problems and persevere in solving them. MP 2. Reason Abstractly and quantitatively. MP4 Model with Mathematics. MP5 Use appropriate tools strategically.

ELA -

- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a problem or solve a problem.

- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text verofying the data when possible, and corroborating or challenging conclusions with other sources of information.

- RST.11_12.9 Synthesize information from a range of sources (e.g. texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept resolving information when possible.

- RST9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

- WHST.9-12.2 Write informative, explanatory texts, including the narration of historical events, scientific procedures, experiments, or technical processes.

WORLD LANGUAGES -

- Students may encounter specific words defining physics whose origin derives from the physicist's home and native language.

VISUAL/PERFORMING ARTS -

- Students can express their understanding of physics in song or pictorially in cartoons. It's all about the story.

APPLIED TECHNOLOGY -

- Whenever possible, highlight the basic physics models that appear in 21st century technological products. Explain and identify interdependent systems and their functions. Analyze a a product or system for factors such as safety, reliability, economic considerations, quality control, manufacturability, maintenance and repair, and human factors engineering(ergonomics).

BUSINESS EDUCATION -

- Is a product cost-effective to make?

GLOBAL AWARENESS -

- Discuss student applications from around the world who use their knowledge of physics ro solve pain-points in their lives. Examples obtained from local and national newspapers and the world-wide web.

Learning Plan / Pacing Guide

Week #1

"Types of Energy" Web Quest (2 periods)

PHET – Energy Skate Park Simulation (2 periods)

Qualitative Energy Analysis (Pie Charts) – AMTA Practice / Whiteboard (1 period)

Physics Classroom Concept Builders – Name That Energy (1 period)

Week #2

PHET – Energy Forms and Changes (2 periods)

Qualitative Energy Storage & Conservation with Bar Graphs – AMTA Practice / Whiteboard (2 periods)

"Work & Energy" and "Stopping Distance" – Physics Classroom Interactives (2 periods)

Week #3

Quiz A – Pie Graph and "LOL" Charts – Qualitative Representations (1 period)

Quantifying Energy - Equations (1 period)

Quantitative Energy Storage & Conservation (LOL Charts) – AMTA Practice / Whiteboard (2 periods)

PBA – Quantitative Energy Transfer Analysis (2 periods)

Week #4

"Chart That Motion" – Physics Classroom Interactives (1 period)

Physics Classroom Concept Builders – "What Up (and Down) with KE and PE?" and "Energy Ranking Tasks" (2 periods)

Quantitative Energy Calculations & Conservation (LOL Charts) – AMTA Practice / Whiteboard (2 periods)

Quiz B – Quantitative Energy Conservation (1 period)

Week #5

PBA – Types of Energy Independent Research - Google Slides (2 periods)

Egg Lander Challenge (3 periods)

Physics Classroom Concept Builders – "Work" (1 period)

Week #6

Energy Transfer and Power – AMTA Practice / Whiteboard (2 periods)

Quiz C – Energy Transfer and Power (1 period)

PHET Simulations – "Hooke's Law" and "Masses and Springs" (2 periods)

Physics Classroom Interactive – Vibrating Mass on a Spring" (1 period)

Week #7

Unit Test Review (2 periods)

Unit 6 (Energy) Test (1 period)

Solar Oven Challenge (3 periods)

**Students in the Honors Physics Course will also complete activities from the "College Physics" by Etkina (Pearson 2014) online textbook which includes

"The Active Learning Guide" (ALG).**

**Students in the Honors Physics Course will also be assessed to a more rigorous standard. **

AP Physics 1 follows a separate set of standards set forth by the College Board.

This curriculum Unit would correlate with AP Unit 4 whose science practices are identified here:

Week#1: Using a system approach, define work and energy qualitatively and quantitatively, including negative and zero work.

Week#2: Is the energy of an isolated system constant? Use Work-energy bar charts to represent processes. Define Work, gravitational potential energy,

kinetic energy, elastic potential energy, internal energy, thermal energy, and finally chemical energy qualitatively

Week#3: Use the generalized work-energy principle to define the total energy of a system as the sum of the different types of energy.

Week#4: Quantify gravitational potential, kinetic, and elastic potential energy (Hooke's Law).

Week#5: Friction and Energy Conversion, the effect of friction as a change in internal energy.

Week#6: Develop skills for analyzing processes using the work-energy principle.

Week#7: Analyze collisions using momentum and energy principles.

Week#8: Define Power. Use model for gravitational potential energy to calculate the escape speed from a planet.

Week#9: Quiz, Lab Practicum, Unit Test.

*** Unit 7 - Electrostatics, Electric & Magnetic Fields, Circuits***

Content Area:	**Science**
Course(s):	**CP PHYSICS**
Time Period:	**Marking Period 4**
Length:	**3 weeks**
Status:	**Published**

Standards and Phenomena

Science Standards

HE.9-12.2.1.12.EH.1	Recognize one's personal traits, strengths, and limitations and identify how to develop skills to support a healthy lifestyle.
HE.9-12.2.1.12.SSH.4	Demonstrate strategies to prevent, manage, or resolve interpersonal conflicts without harming self or others (defining and understanding the laws of consent and dating violence).
SCI.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.
SCI.HS-PS4-2	Evaluate questions about the advantages of using a digital transmission and storage of information.
SCI.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.
SCI.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.
SCI.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.
SCI.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.
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.DC.3	Evaluate the social and economic implications of privacy in the context of safety, law, or ethics (e.g., 6.3.12.HistoryCA.1).
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
	Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.

Phenomena

Science and Engineering Practices

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Use mathematical representations of phenomena to describe explanations.

Use a model to predict the relationships between systems or between components of a system.

Create a computational model or simulation of a phenomenon, designed device, process, or system.

Disciplinary Core Ideas

"Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents.

Newton's second law accurately predicts changes in the motion of macroscopic objects.

Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.

Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.

Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

Crosscutting Concepts

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

The total amount of energy and matter in closed systems is conserved.

Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Systems can be designed to cause a desired effect.

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

Much of science deals with constructing explanations of how things change and how they remain stable.

Transfer Goals

In this unit of study, students' understanding of how forces at a distance can be explained by fields, why some materials are attracted to each other while other are not, how magnets or electric currents cause magnetic fields, and how charges or changing magnetic fields cause electric fields. Electric charge is a property of an object or system that affects its interaction with other objects or systems containing charge. Resitive elements within a circuit consume electrical energy. Most buildings are wired in parallel for maximum efficiency. Circuit breakers and fuses are safety devices designed within circuits to maintain safety.

Concepts

Essential Questions

- How are voltage, current, and resistance related?
- How can an object become positively or negatively charged?
- How does the resistance of a resistor affect power consumption within a circuit?
- How is the electrostatic force similar to the gravitational force?
- What are the relationships between electric currents and magnetic fields?
- What is electric charge, and how is it distinct from other properties of matter?
- What is required for an electrical circuit?
- What type of mathematical relationship does electrostatic force have with distance?
- Why are most building wired in parallel?
- Why are neutral objects attracted to both positive and negatively charged objects?

Understandings

Electrostatics is the study of forces between charges, as described by Coulomb's Law. Students will develop the concept of an electric field surrounding charges. They will work through examples of the electric field near a line, and near a plane, and develop formal definitions of both *electric potential* and *voltage*.

Electromagnetism has two meanings, depending on whether viewed at the subatomic level or on an everyday scale.

At the subatomic level, electromagnetism is defined as the force between electrically charged particles. It is considered one of the fundamental interactions of matter. Oscillating electrical charges result in electromagnetic waves.

On a larger scale, electromagnetism is the creation of a magnetic field from the movement of electrical charges. It usually concerns the use of electric current to make electromagnets, which is called *electrodynamics*. Another effect is *electromagnetic induction*, which is using an electromagnet or changing magnetic field to induce an electric current.

Critical Knowledge and Skills

Knowledge

Students will know:

- Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space.
- Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.
- “Electrical energy” may mean energy stored in a battery or energy transmitted by electric currents.
- When two objects interacting through a field change relative position, the energy stored in the field is changed.
- Cause-and-effect relationships between electrical and magnetic fields can be predicted through an understanding of inter- and intra-molecular forces (protons and electrons).
- Charged objects interact, and this interaction depends on the magnitude of the charge and the distance between the objects.
- Charge is a physical property of protons and electrons
- When electrons and protons are present in equal numbers the net charge of the object containing these particles is zero.
- A charge affects the space around it and charges interact over a distance this interaction can be modeled as a field emitted in all directions.
- Charged particles can move within a material and to other materials depending on the specific qualities of that material.
- The brightness of a light bulb in a combination circuit can be inferred from a qualitative application of Kirchoff's voltage and current laws and Ohm's Law
- Electrical charge is not manufactured by a battery, but "pushed" by the battery through a circuit

Skills

Students will be able to:

- qualitatively and quantitatively explain why a light bulb is dim in one circuit and the same type of bulb is bright in another circuit.
- develop a mechanism to explain the repulsion of the same objects rubbed with the same material as well asf the attraction of objects rubbed with different materials.
- develop a charged particle model for insulators and conductors, how charged particles move within a material and are transferred between materials
- use charge diagrams to reason about electrostatic phenomena
- create a force at a distance model for the force exerted by two electrically charged objects, Coulomb's Law
- compare and contrast Newton's Law of Universal Gravitation to Coulomb's Law and explain the similarities and differences
- explain how the basic unit of charge is a coulomb and how the smallest amount of charge is the charge of an electron
- develop the idea of an electric field as the force that would be exerted on a test charge placed at a fixed location from the source charge
- draw electric field vectors for positive and negative charges

- analyze situations involving multiple source charges
- define electric current and explain conventional current
- discuss the purpose of a battery and the concepts behind the creation of a potential difference
- construct the meaning of electrical resistance and relate it to current and electromotive force both conceptually and mathematically
- apply ohm's law to solve problems and make qualitative predictions using the Law of Conservation of Energy.
- explain and mathematically model the relationships between resistance, cross-sectional area, resistor length, and resistivity
- calculate the equivalent resistance of series and parallel resistors and batteries
- determine the electric current at every point in a combination series and parallel circuit, and the electric potential difference between any two points.
- explain the usage and fuction of an ammeter and a voltmeter
- apply Kirchoff's Loop Rule and Kirchoff's Junction Rule to analyze circuits, and relate them to the Laws of Conservation of Energy and Conservation of Charge respectively.
- observe how a magnet and a current-carrying coil of wire affect a compass.
- electric power, the rate of electric energy conversion. is directly related to the brightness of a bulb

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

Daily whiteboarding or discussion of homework problems from Modeling Curriculum, Active Learning Guide(ALG) or teacher designed scenarios all using Socratic Dialogue.

Assigned Homework.

Physics Classroom Tutorial – Current Electricity

PHET Simulations – Resistance in a Wire, Battery Voltage, Ohm's Law

Physics Classroom Concept Builders - Current

Physics Classroom Concept Builders – Resistance Rankings Tasks

Ohm's Law Lab

PHET - Circuit Construction Kit – AC & DC

Physics Classroom Concept Builders – Know Your Potential

Light Bulb Brightness Lab

School Summative Assessment Plan

PBA – Parallel and Series Challenge

Given a 4 bulb combination circuit (identical bulbs), students will demonstrate how the circuit is wired by drawing a schematic diagram.

The brightness of the bulbs change when one or more bulbs rae removed from the circuit.

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GLOBAL AWARENESS - Discuss student applications from around the world who use their knowledge of physics ro solve pain-points in their lives. Examples obtained from local and national newspapers and the world-wide web.

Learning Plan / Pacing Guide

Week #1

Physics Classroom Tutorial – Current Electricity (2 periods)

PHET Simulations – Resistance in a Wire, Battery Voltage, Ohm's Law (3 periods)

Physics Classroom Concept Builders - Current (1 period)

Week #2

Physics Classroom Concept Builders – Resistance Rankings Tasks (1 period)

Ohm's Law Lab (2 periods)

PHET - Circuit Construction Kit – AC & DC (2 periods)

Physics Classroom Concept Builders – Know Your Potential (1 period)

Week #3

Light Bulb Brightness Lab (2 periods)

PBA – Parallel and Series Challenge (3 periods)

**Students in the Honors Physics Course will also complete activities from the "College Physics" by Etkina (Pearson 2014) online textbook which includes

“The Active Learning Guide” (ALG).**

**Students in the Honors Physics Course will also be assessed to a more rigorous standard. **

AP Physics 1 follows a separate set of standards set forth by the College Board.

This curriculum Unit would correlate with AP Unit 8 whose science practices are identified here:

Week#1: Electrostatic Interactions. Charged objects attract uncharged objects. Explanations for electrostatic interactions.

Week#2: Conductors and Insulators(dielectrics). Properties of electric charge.

Week#3: Coulomb's force law. Electric potential energy. Graphing the electrical potential energy versus distance. Electric potential energy of multiple charge systems.

Week#4: Electric field due to multiple charged objects. Skills for analyzing processes involving E Fields.

Week#5: The V field is called the electric potential. Fiding the electric potential energy when the V field is known. Equipotential surfaces. Relating the E and V fields.

Week#6: Electric field of a charged conductor. Grounding. Shielding. Dielectric materials in an electric field. Capacitors.

Week#7: DC Circuits. Electric Current. Batteries and emf. Making and representing simple circuits. Using ammeters and voltmeters.

Week#8: Ohm's Law. Qualitative and quantitative analysis of series and parallel circuits.

Week#9: Joule's Law for electric power. Kirchoff's loop and junction rules. The internal resistance of a battery. Resistor and capacitor circuits.

Week#10: Qualitative and quantitative reasoning about electric circuits.

Week#11: Skills for solving circuit problems.

Week#12: Quiz, Lab Practicum, Unit Test.

*** Unit 8 - Wave Phenomenon***

Content Area:	**Science**
Course(s):	**CP PHYSICS**
Time Period:	**Marking Period 1**
Length:	**weeks**
Status:	**Published**

Standards and Phenomena

Science Standards

HE.9-12.2.1.12.EH.1	Recognize one's personal traits, strengths, and limitations and identify how to develop skills to support a healthy lifestyle.
HE.9-12.2.1.12.SSH.4	Demonstrate strategies to prevent, manage, or resolve interpersonal conflicts without harming self or others (defining and understanding the laws of consent and dating violence).
SCI.HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
SCI.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.
SCI.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.
SCI.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.
SCI.HS-PS4-2	Evaluate questions about the advantages of using a digital transmission and storage of information.
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.DC.3	Evaluate the social and economic implications of privacy in the context of safety, law, or ethics (e.g., 6.3.12.HistoryCA.1).
TECH.9.4.12.DC.8	Explain how increased network connectivity and computing capabilities of everyday objects allow for innovative technological approaches to climate protection.
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
	When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.
	Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is

useful for explaining many features of electromagnetic radiation, and the particle model explains other features.

Phenomena

Science and Engineering Practices

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.

Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Use a model based on evidence to illustrate the relationships between systems or between components of a system.

Use mathematical representations of phenomena to describe explanations.

Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Create a computational model or simulation of a phenomenon, designed device, process, or system.

Disciplinary Core Ideas

The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.

Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.

Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other.

Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses.

Crosscutting Concepts

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Cause and Effect

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

The total amount of energy and matter in closed systems is conserved.

Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Systems can be designed to cause a desired effect.

Much of science deals with constructing explanations of how things change and how they remain stable.

Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Transfer Goals

In this unit of study, students apply their understanding of how wave properties can be used to transfer information across long distances, store information, and investigate nature on many scales. Students first learn the fundamentals of mechanical waves. Students are then able to 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. Students also demonstrate their understanding of engineering ideas by presenting information about how technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Concepts

Essential Questions

- How are instruments that transmit and detect waves used to extend human senses? e.g. ultrasonic sensor
- How can one dtermine the notes that are possible with a wind instrument?
- How does a smartphone work?
- How is the velocity, wavelength, and frequency of a wave related?
- What are the characteristics, properties, and behaviors of waves?
- What are the different types of waves?

Understandings

Waves get less intense as they travel farther away from where they started.

After a wave passes, the medium that the wave is traveling in will return to where it was before the wave.

Sound carries energy in the form of a traveling wave of compressions and expansions.

Musical instruments are designed using the laws of physics to form standing waves.

Waves are traveling oscillations that carry energy.

Waves can transmit information across a variety of medium.

Radi waves, microwaves, visible light, and x-rays are different examples of the same phenomena.

Critical Knowledge and Skills

Knowledge

Students will know:

- The wavelength and frequency of a wave related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.
- The relationships among the frequency, wavelength, and speed of waves traveling in various media.
- Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other.
- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.
- A wave model or a particle model (e.g., physical, mathematical, computer models) can be used to describe electromagnetic radiation—including energy, matter, and information flows—within and between systems at different scales.
- Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses.
- When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X- rays, gamma rays) can ionize atoms and cause damage to living cells.
- Photoelectric materials emit electrons when they absorb light of a high enough frequency.
- Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.

Skills

Students will be able to:

- Explain the link between oscillations and waves.
- Define and give key characteristics of longitudinal and transverse waves.
- Apply the relations between velocity, period, and frequency of a wave.
- Identify the variables that affect wave speed in a medium.
- Describe the relations between the energy of a wave and its amplitude
- Solve problems regarding waves on a string, water waves and sound waves.
- State and utilize the principle of superposition.
- Describe the properties and necessary criteria for standing waves.
- Describe the key characteristics of sound waves, and the physical meaning of harmonics.
- Apply and perhaps derive relationships for calculating the important frequencies for open and closed pipes.
- Identify a graph of a traveling wave to determine the amplitude, wavelength, period and frequency of

the wave.

- Differentiate between transverse and longitudinal waves.
- Sketch the possible modes for standing waves on a string of fixed length to determine the amplitude, frequency, and wavelength of a particular standing wave.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

Daily whiteboarding or discussion of homework problems from Modeling Curriculum, Active Learning Guide(ALG) or teacher designed scenarios all using Socratic Dialogue.

Assigned Homework.

Quizzes.

School Summative Assessment Plan

Unit Test and a major performance assessment.

Performance Assessment: (1) Successfully build a standing wave using skewers and gummy bears and measure its fundamental frequency.

Primary Resources

AMTA Modeling Physics Program(2013)

http://modelinginstruction.org/

Rutgers Physics Unified Mathematics(PUM) online resources

http://pum.rutgers.edu/

Honors Physics:

College Physics by Etkina Pearson 2014 online textbook which includes

“The Active Learning Guide” (ALG)

Supplementary Resources

Walter Fendt HTML5 Standing Wave Simulations http://www.walter-fendt.de/html5/phen/
Phet Simulations
Vernier Ultrasonic Sensors(Motion, Force, Photogates)
Teacher designed powerpoints and/or Google Docs
TIPERs Sensemaking Tasks for Introductory Physics Pearson 2015
Direct Measurement Videos serc.carleton.edu/dmvideos/index.html
The Universe and More http://theuniverseandmore.com

The Physics Classroom http://www.physicsclassroom.com/
Google Docs on Teachers Website or Google Classroom

Technology Integration and Differentiated Instruction

Technology Integration

Google Products

Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)

GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

One to One Student's laptop

All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

PhET - Founded in 2002 by Nobel Laureate Carl Wieman, the PhET Interactive Simulations project at the University of Colorado Boulder creates free interactive math and science simulations. PhET sims are based on extensive education research and engage students through an intuitive, game-like environment where students learn through exploration and discovery.

The Physics Classroom - The Physics Classroom is an online, free to use physics website developed primarily for beginning physics students and their teachers. The website features a variety of sections intended to support both teachers and students in the tasks of learning and teaching physics.

Additional Support Videos

The videos below are just examples of videos that can be used to support each of the Lessons within this Topic. There are more additional videos provided for each and can be viewed either in the classroom on the Smart Board or through links created on the Google Classroom.

The Physics Circus - a video collection produced through the University of Minnesota Physics Department Faculty.

Khan Academy

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

All assignments have been created in the student's native language.

Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - MP1 Make sense of problems and persevere in solving them. MP 2. Reason Abstractly and quantitatively. MP4 Model with Mathematics. MP5 Use appropriate tools strategically.

ELA - RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a problem or solve a problem.

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text verofying the data when possible, and corroborating or conclusions with other sources of information.

RST.11_12.9 Synthesize information from a range of sources (e.g. texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving information when possible.

RST9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

WHST.9-12.2 Write informative, explanatory texts, including the narration of historical events, scientific procedures, experiments, or technical processes.

WORLD LANGUAGES - Students may encounter specific words defining physics whose origin derives from the physicist's home and native language.

VISUAL/PERFORMING ARTS - Students can express their understanding of physics in song or pictorially in cartoons. It's all about the story.

APPLIED TECHNOLOGY - Whenever possible, highlight the basic physics models that appear in 21st century technological products. Explain and identify interdependent systems and their functions. Analyze a a product or system for factors such as safety, reliability, economic considerations, quality control, manufacturability, maintenance and repair, and human factors engineering(ergonomics).

BUSINESS EDUCATION - Is a product cost-effective to make?

GLOBAL AWARENESS - Discuss student applications from around the world who use their knowledge of physics ro solve pain-points in their lives. Examples would include newspapers and the world-wide web.

Learning Plan / Pacing Guide

Week 1:

Qualitative Analysis and Kinematics Description of Waves:

Hook up a cart to a spring and attach spring to end block. Cart is sitting on a low friction track. Pull the cart back. Observe the oscillation. Record the oscillation with a motion sensor. A sinusoidal oscillation occurs. Find the amplitude and period of oscillation from the graph.

Fasten one end of a metal Slinky toy to the end of a desk leg. Stretch the slinky horizontally so it is about 3 – 4 m long. Create a longitudinal wave by pushing the end of the slinky. How does the speed change if you push less abruptly? Sketch a longitudinal wave that has an amplitude of 3.0 cm, 2.0 Hz frequency, and a 3.0 m/s speed. Reason why $f = 1/T$

Verify that a periodic wave disturbance can be explained by the equation: $y = A \cos 2\pi (t/T - x/\lambda)$

Work with this equation to realize that $y = y(x, t)$. If time look at $v(x,t)$ and $a(x,t)$

Week 2:

Dynamics Analysis of Waves

Provide students with data so they can arrive at the model $v = (F/\mu)^{1/2}$ where F is the force exerted on the end of the string and μ is the mass/length of the string.

Wave Interference

Construct the principle of superposition. Two upright, oppositely traveling pulses pass through each other and add together when they are on top of each other.

Week 3:

Standing Waves on String Instruments and in Pipes

Tie one end of a rope to a post and hold the other end in your hand. With your hand, vibrate the rope up and down at different frequencies. At certain frequencies, big amplitude vibrations occur. Sketch the waveforms for first through fourth harmonic. Find the frequency, wavelength, and velocity of each harmonic.

Discuss standing wave frequencies on open-open and open-closed pipes. Derive the fundamental and successive harmonics.

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.

AP Physics 1 follows a separate set of standards set forth by the College Board.

This curriculum Unit would correlate with AP Unit 10 whose science practices are identified here:

Week #1: Observations: pulses and wave motion. Waves and wavefronts, Wave reflections. Mathematical descriptions of a wave.

Week#2: Dynamics of wave motion: speed and the medium. Energy, power, and intensity of waves.

Week#3: Reflection and Impedance. Superposition principle and skills for analyzing wave processes.

Week#4: Sound as a pressure wave. Intensity level, pitch, frequency, and complex sounds. Beat and beat frequencies.

Week#5: Standing waves on strings.. Standing waves in open-open pipes and open-closed pipes. Doppler effect for a source moving relative to the medium.

Week#6: Quiz, lab practicum, Unit Test.

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