Black Horse Pike Regional School District
Science Department
Advanced Placement Physics I Syllabus

Introduction

Advanced Placement Physics I is an introductory college level physics course. Designed using the AP Physics I Curriculum Framework, the course is algebra-based and will be much more conceptual than the previous version of the AP Physics B course. This course will be the first in a two-year sequence and will focus on inquiry-based learning of physical concepts. The course will place an emphasis on scientific practices such as identifying and explaining relationships, developing experimental procedures including data analysis, applying mathematical procedures, and connecting physical concepts presented throughout the course. The material presented in the course will be centered around six "Big Ideas" (Objects vs. Systems, Fields, Forces, System Changes, Conservation Laws, and Waves) and seven "Science Practices" (Models, Mathematics, Scientific Questioning, Data Collection, Data Analysis and Evaluation, Theories, and Cross-Curricular Understanding) identified by AP Central. The course will cover several units while keeping these ideas and practices in mind and will be covered in the outline listed below (**Note:** this course will be implemented for the first time in 2014-2015 and changes in the timeline are to be expected). (NJCCCS for Science @ http://www.state.nj.us/education/cccs/standards/5/, related Core Content Math and LAL @ http://www.state.nj.us/education/sca/ccss/)

Proposed Timeline

September: Introduction to Physical Systems (5.1.12.A.1, 5.2.12.A.2)

Students will explore the major themes of the course including objects vs. systems, vector vs. scalar quantities, and conservable quantities.

1. Objects, systems, and their properties
2. Conservation laws (mass, energy, charge, and momentum)
3. Vector and scalar quantities and mathematics
4. Developing scientific procedures, data collection and evaluation, graphical analysis

September: Kinematics in 1D (5.1.12.A.1-2, 5.1.12.B.1-2, 4, 5.2.12.E.1-2)

Students will identify the major descriptors of motion (position, displacement, time, velocity, and acceleration). Relationships between these variables will be analyzed experimentally, graphically, and mathematically.

1. Define kinematic terms (scalar vs. vector quantities)
2. Algebraic expressions
3. Graphical relationships
4. Reference frames

October: Kinematics in 2D (5.1.12.A.1, 5.2.12.E.1-2)

Students will analyze motion in two dimensions. Specifically students will study objects undergoing projectile motion and the relative velocity of objects when multiple sources are in motion.

1. Reinforcement of vector operations
2. Projectile motion (horizontal and launched at angles)
3. Relative velocity

October: Forces (5.1.12.A.1-3, 5.1.12.B.1-3, 5.2.12.D.2, 5.2.12.E.3-4)

Students will explore the causes of motion. Specifically, they will analyze how Newton's three laws of motion are present in all motion scenarios. The concept of a free-body diagram will be used to assist in analyzing component forces that are contributing to the motion of an object.

1. Net force, component forces and free-body diagrams
2. Newton's laws of motion
3. Forces in two dimensions

November: Field Forces (5.1.12.A.1, 5.2.12.A.1, 5.2.12.E.3)

Students will examine non-contact forces and the factors that affect such forces. In particular, they will look at gravitational force and its dependence on mass and location of objects in a system and electrical force and its dependence on charge and location of objects in a system.

1. Field vs. contact forces

2. Gravitational force
3. Electrical force
4. Introduction to potential energy

November: <u>Uniform Circular Motion</u> (5.1.12.A.1-2, 5.2.12.E.2-4)

Students will investigate objects that are moving in uniform (constant speed) circular motion. In this unit, the concept of centripetal force will be introduced, not as a new force, but rather as a category of force that does not change an object's speed, but rather changes its direction. Students will use old force equations and new circular motion equations to develop and utilize new equations that can be used to solve for aspects of circular motion (mass, speed, force, acceleration, and revolutions)

1. Circular kinematics (speed, radius, acceleration, period and revolutions)
2. Circular dynamics (centripetal force)
3. Development of equations (satellite, turns on ground, banked turns)
4. Vertical circular motion (multiple component forces); hills, dips, and loops

December: <u>Work-Energy</u> (5.1.12.A.1, 5.1.12.B.4, 5.2.12.D.1, 5.2.12.D.4, 5.2.12.E.2)

Students will analyze the motion of objects using the concepts of work and energy. They will use the concept of work when external forces are applied to a system through a distance to describe (qualitatively and quantitatively) how an object's motion will be affected. They will also develop and use an equation in which only conservative forces are applied to a system and thus, can be ignored in a problem. Students will also recognize that such conservative forces must have a potential energy associated with them.

1. Definition of work, work equation, F-d graphs
2. Energy types, mechanical/non-mechanical, kinetic/potential
3. Conservative and non-conservative forces
4. Work-Energy theorem
5. Conservation of mechanical energy
6. Power

December: <u>Impulse-Momentum</u> (5.1.12.A.1, 5.1.12.B.1, 5.1.12.B.4, 5.2.12.D.4, 5.2.12.E.3-4)

Students will modify Newton's second law of motion to develop the impulse-momentum theorem. They will identify momentum as the measure of an object's progress, or, the product of its mass and velocity. Students will recognize that impulse is the product of the average force applied to an object and the time in which the force is applied. An impulse that is imparted to a system (from and external source) will cause the system's momentum to change. When all forces are included in the system, the conservation of momentum can be applied and all forces within the system can be ignored.

1. Impulse-Momentum theorem, definition of impulse and momentum, Newton's second law
2. Conservation of momentum in one and two dimensions
3. Collisions (elastic and inelastic), momentum conservation in collisions, mechanical energy loss in collisions

January: <u>Rotational Kinematics</u> (5.1.12.A.1, 5.1.12.B.1, 5.2.12.E.1-3)

Students will analyze the motion of rotating objects. Specifically students will study rolling objects and objects rotating about a fixed axis. Students will develop and utilize equations analogous to the straight line kinematic equations using rotational counterparts.

1. Angular vs. translation quantities
2. Kinematics equations for rotational motion
3. Rolling motion

January: <u>Rotational Dynamics</u> (5.1.12.A.1, 5.1.12.B.1-4, 5.2.12.E.1-2)

Students will explore the causes of rotational motion. Specifically, they will analyze how Newton's three laws of motion are present in all rotating motion scenarios. Students will examine and explain the conservation laws for angular momentum and angular kinetic energy.

1. Torque and rotational inertia
2. Rotational equilibrium
3. Rotational kinetic energy
4. Angular momentum
5. Conservation of angular momentum

February: <u>SHM and Elasticity</u> (5.1.12.A.1, 5.1.12.B.1-4, 5.2.12.E.1-2)

Students will investigate a special category of motion known as simple harmonic motion (SHM) and its behavior in pendulums and springs. Students should be able to determine that simple harmonic motion is different from other forms of motion previously discussed in that displacement, velocity, and acceleration are never constant, and are changing in a predictable pattern that when plotted as a function of time, and produce a sine curve. The reasons for variable forces affecting the motion of oscillating objects will be examined.

1. Characteristics of SHM
2. Energy in SHM
3. Sinusoidal nature of SHM
4. Springs and simple pendulums

February: <u>Waves and Sound</u> (5.1.12.A.1, 5.1.12.B.1-4, 5.2.12.E.2)

Students will analyze wave motion by examining the characteristics of waves and the equations that define the motion of a wave as it varies over time. An analogy between the motion of waves and SHM will be examined. Students will use their knowledge of wave behavior as it differs from the behavior of objects such as reflection refraction, and diffraction. Students will also use wave theory to explain other wave behaviors such as intensity and Doppler effect.

1. Wave motion, transverse and longitudinal waves, mechanical and electromagnetic waves
2. Sound characteristics, intensity, intensity level
3. Speed of sound
4. Doppler effect, sonic booms
5. Reflection and its uses (SONAR and ultrasound imaging)

March: <u>Wave Superposition</u> (5.1.12.A.1, 5.1.12.B.1-4, 5.2.12.E.1-2)

Students will investigate the effects of two or more waves occupying the same space at the same time using the principle of superposition to add amplitudes to find the resulting amplitude. Students will use this knowledge to explain the phenomenon of beats, interference, resonance, standing waves and musical instruments.

1. Interference (constructive and destructive)
2. Resonance and standing waves
3. Diffraction and beats
4. Musical instruments

March: <u>Introductory Electrical Circuits</u> (5.1.12.A.1, 5.1.12.B.1-4, 5.2.12.E.2)

Students will define and explain the four major terms related to electrical energy (voltage, current, resistance and power). Students will investigate the relationships between these terms in an electric circuit. Students will use the conservation laws of charge and energy to explain the operation of electric circuits.

1. Electric charge and its conservation
2. Current, voltage, resistance and electrical power
3. Ohm's law and electric power
4. Electric circuits, schematics, series and parallel circuits
5. Kirchoff's rules (loop and junction rule)

April: <u>Yearly Wrap-Up and Exam Review</u>
May-June: <u>Final Project</u>

<u>Course Expectations & Skills</u>

1. Design and develop procedures to test physical relationships
2. Use graphical analysis to determine or verify relationships between physical variables
3. Develop logical conclusions from experimental data
4. Write college-level lab reports
5. Explain the causes of various types of motion
6. Identify and explain physical phenomena by using conservation principles (mass, energy, momentum, and charge)
7. Use free-body diagrams as a problem solving tool to solve for physical phenomena
8. Use the concept of object vs. system
9. Understand the difference behind vector and scalar mathematics
10. Devise procedures to model and verify physical phenomena

<u>Primary Text</u>

Physics: Principles & Applications 7th edition, 2014 Pearson

<u>Grading Scale</u>

Grades are calculated according to the following proportions:

Tests/Quizzes: 50% Labs/Homework/Classwork: 50%

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 1 – Introduction to Physical Systems

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/Intro to Physical Systems** **Grade Level(s):** **11-12**	**Unit Summary**: This introductory unit will acquaint students with the major themes of the course: properties of matter, systems vs. objects, conservation of quantities, vector vs. scalar quantities, and fields.
Essential Question(s): • How are properties determined by the internal structure of matter? • What is the difference between a vector and a scalar quantity? • What is the difference between a system and an object? • Define and provide an example of a conservative quantity? • What is a vector field? • What are the characteristics of a vector field?	**Enduring Understanding(s):** • The internal structure of a system determines many properties of the system • Systems have properties determined by the properties and interactions of their constituent atomic and molecular substructures • A system of particles can be considered an object when the properties of the constituent parts are not important in modeling the behavior • Electric charge is a property of an object or system that affects its interactions with other objects or systems containing charge • There are fundamental properties of systems that obey conservation laws. These properties are mass, energy, momentum, and charge • A vector is any quantity that includes both magnitude and direction. A scalar is any quantity with only magnitude • Direction must be accounted for when combining vector quantities

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	**NJCCCS or CCS**
1. Construct representations of the differences between a fundamental particle and a system composed of fundamental particles and to relate this to the properties and scales of the systems being investigated (target identified by AP Central) **2.** Model verbally or visually the properties of a system based on its substructure and to relate this to changes in the system properties over time as external variables are changed (target identified by AP Central) **3.** Evaluate using given data whether all the forces on a system or whether all the parts of a system have been identified (target identified by AP Central) **4.** Define open and closed systems for everyday situations and apply conservation concepts for energy, charge, and linear momentum to those situations (target identified by AP Central) **5.** Recognize that it is the internal microscopic structure of matter that determines macroscopic behavior **6.** Recognize the defining characteristics of vector quantities vs. scalar quantities and how they differ **7.** Recognize the defining characteristics of systems vs. objects and how they differ **8.** Recognize a conservative quantity and compare how it differs from a non- conservative quantity **9.** Recognize the defining characteristics of vector fields vs. individual vectors **10.** Determine the resultant of a combination of vectors using the graphical method of vector addition **11.** Resolve any combination of vectors using x- and y- components and trigonometry **12.** Recognize the characteristics of a vector field **13.** Use a vector field to find the value of a quantity for an object in the field	**1. 5.1.12.A.1,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2 RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **2. 5.1.12.A.1** **3. 5.1.12.A.1** **4. 5.1.12.A.1** **5. 5.1.12.A.1, 5.2.12.A.1,** 6.1.12.C.12, 6.1.12.C16, 6.2.12.C.5, 7.1.IL.A.7, 9.1.12.A.1, 9.1.12.B, 9.4O, RI.11-12, RST.9-10 or RST.11-12, WHST.11-12 **6. 5.1.12.A.1** **7. 5.1.12.A.1** **8. 5.1.12.A.1** **9. 5.1.12.A.1** **10. 5.1.12.A.1** **11. 5.1.12.A.1** **12. 5.1.12.A.1** **13. 5.1.12.A.1**

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Most concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance.

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures, Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate them. Students will also write explanations with diagrams for time dependent labs.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a “Unit in Review” poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a “How It Works” project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/01 Intro to Physical Systems folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. {K, C, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:
Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Performance Assessments:

Students will be required to turn in homework, and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:
Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 2 – Kinematics in 1D

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/ Kinematics in 1D** **Grade Level(s):** **11-12**	**Unit Summary**: This unit will introduce quantitative descriptions of motion. In particular, students will investigate the relationships among position, velocity, and acceleration as related to the motion of an object in a straight line path. There are two ways to analyze motion in this course: algebraically and graphically. There are basic equations of kinematics that can be used to describe objects that are undergoing a constant motion. There are three types of motion that will be analyzed in this unit: rest, constant velocity, and constant acceleration. There are kinematics equations that can be applied in a given type of motion that can be used to predict other variables when provided sufficient information relating to other variables. Objects that undergo constant velocity can utilize one equation. Objects that undergo constant acceleration can be analyzed using one of four kinematics equations. When plotted as a function of time, motion can also be analyzed graphically. Slopes can be used to determine rates of change and the area under a velocity-time graph will determine position and area under an acceleration-time graph will determine velocity.
Essential Question(s): • How can I describe the motion of an object travelling in a straight line? • What is displacement? • What is velocity? • What is acceleration? • How do displacement, velocity and acceleration vary over time?	**Enduring Understanding(s):** • The motion of an object in a straight line can be completely described by specifying the position, velocity and acceleration of an object at any given time • Displacement is a vector noting the location of the object at any time. The starting and ending positions can be used to calculate how far an object has moved, its displacement • Velocity is a vector noting the change in position over time. Velocity can be measured by recording the position at the starting time and the position at the final time. The starting position is subtracted from the initial position and this quantity is divided by the elapsed time. • Acceleration is a vector noting the change in velocity over time. Acceleration can be measured by recording the velocity at the starting time and the velocity at the final time and dividing by the elapsed time. • The position, velocity and acceleration can vary over time. This variation over time can be accounted for by a set of equations collectively known as the kinematic equations. • An observer in a particular reference frame can describe the motion of an object using such quantities as position, displacement, distance, velocity,

	speed, and acceleration • A choice of reference frame determines the direction and the magnitude of each of these quantities

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target: Students will be able to…	**NJCCCS or CCS**
1. Express the motion of an object using narrative, mathematical, and graphical representations (target identified by AP Central) **2.** Design an experimental investigation of the motion of an object (target identified by AP Central) **3.** Analyze experimental data describing the motion of an object and express the results of the analysis using narrative, mathematical, and graphical representations (target identified by AP Central) **4.** Recognize the definitions, symbols and units of displacement, velocity, and acceleration **5.** Make predictions about the motion of a system based on the fact that velocity is equal to the change in position per unit time (target identified by AP Central) **6.** Make predictions about the motion of a system based on the fact that acceleration is equal to the change in velocity per unit time (target identified by AP Central) **7.** Create mathematical models and analyze graphical relationships for acceleration, velocity, and position of the center of mass of a system and use them to calculate properties of the motion of the center of mass of a system (target identified by AP Central) **8.** Recognize that the slope of a position-time graph at a given time is the instantaneous velocity and the slope of the velocity versus time graph is the acceleration **9.** Use the area under curves to determine kinematic variables **10.** Apply kinematic equations to mathematically determine any of the five variables of kinematics (for constant velocity or constant acceleration) **11.** Use the kinematic equations and graphical analysis to describe freely falling bodies undergoing constant acceleration ($g = 9.8\ m/s^2$)	**1.** **5.1.12.A.1,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2), RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **5.2.12.E.1,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, A-REI.3, 6, RST.11-12.1, 2, 3, 4, **5.2.12.E.2,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-CN.1, 4, 6, N-Q.1, 2, 3, N-VM.1, 4, 5, RST.11-12.1, 2, 3, 4 **2.** **5.1.12.A.1, 5.1.12.B.1,** 2.2.12.B.1, 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 9.1.12.A.1, 9.1.12.B, 9.4O, RST.11-12.1 through 10, WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.2.12.E.1, 5.2.12.E.2** **3.** **5.1.12.A.1, 5.1.12.A.2,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 9.1.12.A.1, 9.1.12.B, 9.1F, 9.4O, RST.11-12.1 through 10, N-R.1 through

	3, N-Q.1 through 3, S-ID.1 **5.1.12.B.2,** 2.2.12.B.1, 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 9.1.12.A.1, 9.1.12.B, 9.4O, RST.11-12.1 through 10, WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.1.12.B.4,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 9.1.12.A.1, 9.1.12.B, 9.4O, RST.11-12.1 through 10, WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.2.12.E.1, 5.2.12.E.2** 4. **5.1.12.A.1, 5.2.12.E.1** 5. **5.1.12.A.1, 5.2.12.E.1, 5.2.12.E.2** 6. **5.1.12.A.1, 5.2.12.E.1, 5.2.12.E.2** 7. **5.1.12.A.1, 5.1.12.B.2, 5.1.12.B.4, 5.2.12.E.1, 5.2.12.E.2** 8. **5.1.12.A.1, 5.1.12.B.2, 5.1.12.B.4, 5.2.12.E.1, 5.2.12.E.2** 9. **5.1.12.A.1, 5.1.12.B.2, 5.1.12.B.4, 5.2.12.E.1, 5.2.12.E.2** 10. **5.1.12.A.1, 5.2.12.E.1, 5.2.12.E.2** 11. **5.1.12.A.1, 5.2.12.E.1, 5.2.12.E.2**

Inter-Disciplinary Connections:

Students will interact with text and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments of comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Many concepts presented in this unit will incorporate algebra and problem solving skills as well as vector analysis. Technological advancement (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, DataStudio and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance.

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures, Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate them. Students will also write explanations with diagrams for time dependent labs.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will be explore material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Students will work with/investigate concepts through laboratory investigation including:

- Using ultrasonic motion sensors to measure and determine the relationships between position, velocity and time.
- Movie cameras and motion capture software to analyze the motion of an object.
- PhET simulations/Gizmos to discover basics of how objects move.
- Various demonstrations of phenomena such as falling apples to illustrate various points.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students will be presented with the definitions of displacement, velocity and acceleration through the text, lectures, inquiry based demonstrations and interactive lab exercises both virtual and real.

Computer simulations will be used to demonstrate the concepts and allow students to graphically analyze the motion of an object.

Labs will be used to relate the mathematical concepts to the real world.

Students will practice using the kinematic equations to solve problems in class and for homework.

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a "Unit in Review" poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a "How It Works" project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/02 Kinematics in 1-D folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. {K, C, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Performance Assessments:

Students will be required to turn in homework, and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP

Physics review material as further enrichment resources for all topics covered

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 3 – Kinematics in 2D

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/Kinematics in 2D**	**Unit Summary**: This unit will investigate motion that is occurring along two axes. In the first part of the unit, the concept of vector addition will be examined. Vectors that point parallel will add together, vectors that point anti-parallel will subtract from one another, while vectors that point perpendicular will combine using rules of geometry and trigonometry. Vectors that point at other angles will be added using an analytical approach using vector components. In the second part of the unit, the concept of projectile motion will be examined. When an object is launched with some type of horizontal component of the motion and only experiences the force of gravity, it is said to be undergoing projectile motion. In this special case, motions along horizontal and vertical axes are independent from one another. Motion along the horizontal axis will maintain a constant velocity, while the motion along the vertical axis will undergo a constant acceleration. Both components of the motion can be solved separately and are only linked by the time variable.
Grade Level(s): **11-12**	
Essential Question(s): • How can I describe the motion of an object in two dimensions? • What is a vector? • Are displacement, velocity and acceleration vectors? • How do I add and subtract vectors? • Can I use vectors and the kinematic equations to describe the motion of an object in 2 dimensions? • How can I predict the motion of a ball rolling off of a table?	**Enduring Understanding(s):** • Vectors have both magnitude and direction. In order to completely specify a vector, you must specify both quantities • Any single vector can be resolved into at least two equivalent vectors by resolving the vector into components that are parallel to defined axes • Two or more vectors can be added to form an equivalent single vector by using the rules for vector addition • The motion of an object in two dimensions can be described using the fact that the motion is totally independent in each direction. • The motion of an object in each direction can be described using the kinematic equations and concepts of unit on straight line motion • The resulting motion in two dimensions can be found by adding the vectors in each of the two dimensions to arrive at the resultant vector • Projectile motion is motion in which an object undergoes constant acceleration along one axis and constant velocity along another axis

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	**NJCCCS or CCS**
1. Solve for the relative velocity of two or more component velocities 2. Determine the resultant of two of more parallel or antiparallel vectors 3. Determine the resultant of two of more vectors that point at angles using the analytical and graphical methods 4. Recognize that objects undergoing projectile motion will exhibit independence of motion along perpendicular axes 5. Solve for kinematic variables for objects undergoing projectile motion 6. Recognize that the horizontal velocity of a projectile is constant, assuming no forces except gravity act on the object 7. Recognize that the vertical velocity of a projectile is constantly changing, assuming no forces except gravity act on the object	1. **5.1.12.A.1,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2), RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **5.2.12.E.1,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, A-REI.3, 6, RST.11-12.1, 2, 3, 4, **5.2.12.E.2,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-CN.1, 4, 6, N-Q.1, 2, 3, N-VM.1, 4, 5, RST.11-12.1, 2, 3, 4 2. **5.1.12.A.1, 5.2.12.E.1, 5.2.12.E.2** 3. **5.1.12.A.1, 5.2.12.E.1, 5.2.12.E.2** 4. **5.1.12.A.1, 5.2.12.E.1, 5.2.12.E.2** 5. **5.1.12.A.1, 5.2.12.E.1, 5.2.12.E.2** 6. **5.1.12.A.1, 5.2.12.E.1, 5.2.12.E.2** 7. **5.1.12.A.1, 5.2.12.E.1, 5.2.12.E.2**

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Most concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated

in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance.

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures, Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate them. Students will also write explanations with diagrams for time dependent labs.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another

Students will work with/investigate concepts through laboratory investigation including:

- Using ultrasonic motion sensors to measure and determine the relationships between position, velocity and time.
- Movie cameras and motion capture software to analyze the motion of an object.
- PhET simulations/Gizmos to discover basics of how objects move.
- Various demonstrations of phenomena such as falling apples to illustrate various points.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a “Unit in Review” poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a “How It Works” project using HowStuffWorks.com and

concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/03 Kinematics in 2-D folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. {K, C, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:
Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Performance Assessments:

Students will be required to turn in homework, and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:
Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 4 – Forces and Newton's Laws

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/Forces and Newton's Laws** **Grade Level(s):** **11-12**	**Unit Summary:** This unit will introduce the concept of force and Newton's Laws of motion. A force is commonly defined as a push or pull. Forces can be classified in one of two categories: contact forces or field forces. All forces require two objects. As the name suggests, contact forces require contact between the two objects. Examples that will be investigated in this unit will include the applied force, frictional force, normal force, and tension. All forces are governed by Newton's basic three laws of motion. The first law states that an object that is at rest or moving with a constant velocity will continue to do so unless acted upon by an unbalanced force. The second law explains how force and mass are related by causing an object to accelerate. The third law explains how all forces come in pairs and that for every force acting on an object, there is an equal and opposite force acting on another object. The concept of a free-body diagram will also be examined and used to determine how the combination of multiple forces acting on one object will result in a net motion of the object.
Essential Question(s): • How do parallel and perpendicular forces affect motion? • How are force, mass, and acceleration related? • Why do internal forces not have an effect on an object's motion • What forces are acting on an object in a given scenario (including net force)? • What are the most typical forces acting on an object at the Earth's surface?	**Enduring Understanding(s):** • A force is a push or pull that causes changes in the motion of objects • On the Earth, gravitational force is called weight • A force exerted on an object is always due to the interaction of that object with another object • An object cannot exert a force on itself • Even though an object is at rest, there may be forces exerted on that object by other objects • The acceleration of an object interacting with other objects can be predicted by using F=ma. If an object interacts with several other objects, the net force is the vector sum of the individual forces. • The acceleration of an object, but not necessarily its velocity, is always in the direction of the net force exerted on the object by other object. If one object exerts a force on a second object, the second object always exerts a force of equal magnitude on the first object in the opposite direction • Free-body diagrams are useful tools for visualizing forces being exerted on

• How can an object remain at rest while forces are acting on it? • How can action-reaction paired forces explain an object's motion (i.e. push up, trailer pulling)	a single object and writing the equations that represent a physical situation • Contact forces result from the interaction of one object touching another object and they arise from inter-atomic electric forces. These forces include tension, friction, normal, spring

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	NJCCCS or CCS
1. Design an experiment for collecting data to determine the relationship between the mass, acceleration and net force exerted on an object (target identified by AP Central) **2.** Represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation (target identified by AP Central) **3.** Explain contact forces (tension, friction, normal, buoyant, spring) as arising from interatomic electric forces (target identified by AP Central) **4.** Describe the difference between static and kinetic friction **5.** Apply Newton's first law of motion to physical situations, such as seatbelts whiplash **6.** Apply Newton's second law to systems to calculate the change in velocity when an external force is exerted on a system (target identified by AP Central) **7.** Use visual or mathematical representations of the forces between objects in a system to predict whether or not there will be a change in the velocity of that system (target identified by AP Central) **8.** Analyze a scenario and make claims (develop arguments, justify assertions) about the forces exerted on an object by other objects for different types of forces or components of forces (target identified by AP Central) **9.** Challenge a claim that an object can exert a force on itself (target identified by AP Central) **10.** Use Newton's third law to construct explanations and make claims and predictions about the action-reaction pairs of forces when two objects interact (target identified by AP Central) **11.** Analyze situations involving interactions among several objects by using free-body diagrams (target identified by AP Central) **12.** Predict the motion of an object subject to forces exerted by several objects using an application of Newton's second law resulting in acceleration in one dimension (target identified by AP Central) **13.** Design a plan to collect and analyze data for motion (static, constant, or accelerating) from measurements to determine the relationship between the net force and the vector sum of the individual forces (target identified by AP Central)	1. **5.1.12.A.1**, 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2), RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.1.12.A.2**, 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 9.1.12.A.1, 9.1.12.B, 9.1F, 9.4O, RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.2.12.E.4**, 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-CN.1, 4, 6, N-Q.1, 2, 3, N-VM.1, 4, 5, RST.11-12.1, 2, 3, 4, **5.1.12.A.3,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2F, 9.1.12.A.1, 9.1.12.B, , , 9.1F, 9.4O, RST.11-12.1 through 10, WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.1.12.B.1,** 2.2.12.B.1, 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E,

14. Create and use free-body diagrams to analyze physical situations to solve problems with motion qualitatively and quantitatively (target identified by AP Central)	8.1.12.F, 8.2.12.F, 9.1.12.A.1, 9.1.12.B, 9.4O, RST.11-12.1 through 10, WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.1.12.B.2,** 2.2.12.B.1, 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 9.1.12.A.1, 9.1.12.B, 9.4O, RST.11-12.1 through 10, WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.2.12.D.2,** 2.2.12.B.1, 8.1.12.C.1, 9.1.12.A.1, 9.1.12.B, 9.4O L.11-12.6, N-Q.1, RI.11-12.2, 8, RST.11-12.1, 9, 10, S-IC.6, S-ID.1, SL.11-12.1 through 6, S-MD.5, 6, W.11-12.1, 7, WHST.11-12. 1, 5, 7, 8, 9 2. **5.1.12.A.1, 5.1.12.A.2**, **5.2.12.E.3**, 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3 RST.11-12.1, 2, 3, 4, **5.2.12.E.4** **3. 5.1.12.A.1, 5.1.12.A.2**, **5.2.12.E.3**, **5.2.12.E.4** **4. 5.1.12.A.1, 5.1.12.A.2**, **5.2.12.E.3**, **5.2.12.E.4** **5. 5.1.12.A.1, 5.1.12.A.2**, **5.2.12.E.3** **6. 5.1.12.A.1, 5.1.12.A.2**, **5.2.12.E.4** **7. 5.1.12.A.1, 5.1.12.A.2**, **5.2.12.E.4** **8. 5.1.12.A.1, 5.1.12.A.2**, **5.1.12.B.3,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 9.1.12.A.1, 9.1.12.B, 9.4O, RST.11-12.1 through 10,

	WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 9. **5.1.12.A.1, 5.1.12.A.2, 5.1.12.B.3** 10. **5.1.12.A.1, 5.1.12.A.2, 5.1.12.B.3** 11. **5.1.12.A.1, 5.1.12.A.2** 12. **5.1.12.A.1, 5.1.12.A.2, 5.2.12.E.4** 13. **5.1.12.A.1, 5.1.12.A.2, 5.2.12.E.3, 5.2.12.E.4, 5.1.12.A.3, 5.1.12.B.1** 14. **5.1.12.A.1, 5.1.12.A.2**

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Most concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance.

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures, Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate them. Students will also write explanations with diagrams for time dependent labs.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

<u>How</u> will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Students will work with/investigate concepts through laboratory investigation including:

- Using ultrasonic motion sensors to measure and determine the relationships between position, velocity and time.
- Movie cameras and motion capture software to analyze the motion of an object.
- PhET simulations/Gizmos to discover basics of how objects move.
- Various demonstrations of phenomena such as falling apples to illustrate various points.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a “Unit in Review” poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a “How It Works” project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/04 Forces and Newton's Laws folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. {K, C, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old

AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Performance Assessments:

Students will be required to turn in homework, and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 5 – Field Forces

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/Forces and Newton's Laws** **Grade Level(s):** **11-12**	**Unit Summary:** This unit will look specifically at field forces. Field forces are also known as forces-at-distances. These forces do not require contact and can act over very large distances. The concept of a vector field is used to describe the influences of these types of force. A vector field is an assignment of a vector to every point in space and is used to describe an object's influence over another in terms of force strength and direction. Two field forces that will be examined in this unit will be gravitational force and electrical force. The gravitational force is an interaction between the centers of any two spherical objects with mass and is proportional to the masses of the objects and inversely proportional to the square of the distance between the two objects. A gravitational field is a vector representation used to determine the force that would act upon the center of a body that has mass. The electrical force is an interaction between the centers of any two spherical objects with charge and is proportional to the charges of the objects and inversely proportional to the square of the distance between the two objects. An electric field is a vector representation used to determine the force that would act upon the center of a body that has charge. The net force or field acting on an object by multiple field forces can be determined using vector addition. In this approach, the separate interactions of the surrounding objects will be analyzed separately, and then vector added to determine the net force or field.
Essential Question(s): • What are vector fields? • What effects do vector fields cause? • How can I determine the characteristics of vector field effects? • How can I describe the forces on an object due to vector fields? • How are the equations for	**Enduring Understanding(s):** • At the macroscopic level, forces can be categorized as either field forces (gravity, electrical, magnetic, strong) or contact forces(normal, friction, tension, etc) • A field associates a value of some physical quantity with every point in space and is used to describe long-range interactions • Vector fields are represented by field vectors indicating direction and magnitude of a physical quantity that is described by a vector • All forces (field and contact) require two objects • Gravitational force is an attractive force that describes the interaction of one object that has mass with another object that has mass

electric and gravitational fields similar?	• Electrical force is an attractive or repulsive force that describes the interaction of one object that has charge with another object that has charge • The gravitational field caused by a spherically symmetric object is a vector whose magnitude outside the object is equal to $G\ M/r^2$ • The electric field caused by a spherically symmetric object is a vector whose magnitude outside the object is equal to $k\ q/r^2$ • Electric forces dominate the properties of the objects in our everyday experiences. However, the large number of particle interactions that occur make it more convenient to treat everyday forces in terms of nonfundamental forces called contact forces, such as normal force, friction, and tension

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	**NJCCCS or CCS**
1. Apply *F=mg* to calculate the gravitational force on an object with mass *m* in a gravitational field of strength *g* in the context of the effects of a net force on objects and systems (target identified by AP Central)	1. **5.1.12.A.1**, 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2), RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.2.12.E.3**, 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, RST.11-12.1, 2, 3, 4, **5.2.12.E.4**, 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-CN.1, 4, 6, N-Q.1, 2, 3, N-VM.1, 4, 5, RST.11-12.1, 2, 3, 4
2. Apply $g = GM/r^2$ to calculate the gravitational field due to an object with mass *M*, where the field is a vector directed toward the center of the object of mass *M* (target identified by AP Central)	**2. 5.1.12.A.1**
3. Approximate a numerical value of the gravitational field (*g*) near the surface of an object from its radius and mass relative to those of the Earth or other reference objects (target identified by AP Central)	**3. 5.1.12.A.1**
4. Use Newton's law of gravitation to calculate the gravitational force the two objects exert on each other and use that force in contexts other than orbital motion (target identified by AP Central)	**4. 5.1.12.A.1**
5. Use Coulomb's law qualitatively and quantitatively to make predictions about the interaction between two electric point charges (target identified by AP Central)	**5. 5.1.12.A.1, 5.2.12.A.1,** 6.1.12.C.12, 6.1.12.C16, 6.2.12.C.5, 7.1.IL.A.7, 9.1.12.A.1, 9.1.12.B, 9.4O, RI.9-10 or RI.11-12, RST.11-12, WHST.11-12
6. Connect the concepts of gravitational force and electric force to compare similarities and differences between the forces (target identified by AP Central)	**6. 5.1.12.A.1**
7. Articulate situations when the gravitational force is the dominant force and when the electromagnetic, weak, and strong forces can be ignored (target identified by AP Central)	**7. 5.1.12.A.1**

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Most concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance.

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures, Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate them. Students will also write explanations with diagrams for time dependent labs.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Students will work with/investigate concepts through laboratory investigation including:

- Using ultrasonic motion sensors to measure and determine the relationships between position, velocity and time.
- Movie cameras and motion capture software to analyze the motion of an object.
- PhET simulations/Gizmos to discover basics of how objects move.
- Various demonstrations of phenomena such as falling apples to illustrate various points.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a "Unit in Review" poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a "How It Works" project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/05 Field Forces folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. {K, C, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Performance Assessments:

Students will be required to turn in homework, and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 6 – Uniform Circular Motion

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/Uniform Circular Motion** **Grade Level(s):** **11-12**	**Unit Summary**: This unit will explore the topic of uniform circular motion. In this type of motion, an object will move at a constant speed, but constantly changing velocity, and thus, undergoing a constant acceleration. This type of acceleration is known as centripetal acceleration and will point perpendicular to the velocity at any given instant. Because the object is accelerating in accord with Newton's second law, there must be a force causing this acceleration. This force is known as a centripetal force and is always in the same direction as the acceleration and perpendicular to the instantaneous velocity of the moving object. It is important to note that centripetal force is not a new type of force and can be in the form of many other forces discussed in previous sections (friction, normal, gravity, tension, etc…).
Essential Question(s): • What makes objects travel in circles? • Why are objects that are travelling in circles always accelerating? • What is centripetal force? • What type of force creates the centripetal force in a given situation? • Why are race track curves banked? • Why does the Moon stay in orbit?	**Enduring Understanding(s):** • Uniform circular motion occurs when an object travels in a circle at constant speed but whose velocity continually changes direction • A force is always required in order for an object to travel in uniform circular motion. This force must be exerted on the object and is always directed to the center of the circle • Centripetal force is not a new force. It is produced by any other force such as friction, tension, gravity, or normal force • Newton's laws apply to objects undergoing uniform circular motion except that the acceleration is equal to the velocity squared divided by the radius of the circle • Newton's law of universal gravitation can be used to calculate orbital velocity and period

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	NJCCCS or CCS
1. Describe the nature of uniform circular motion in terms of the	**1.** **5.1.12.A.1**, 8.1.12.A,

objects speed, changing direction and acceleration and the force that must be applied to cause circular motion **2.** Apply equations for uniform circular motion in solving problems for an object moving in a horizontal circle **3.** Describe the difference between centripetal (radial) acceleration and tangential acceleration **4.** Define period of motion and frequency for an object moving in a circular path **5.** Identify the forces causing centripetal acceleration in various situations (flat road, banked turn, satellites, artificial gravity) and develop the appropriate equation to solve for the missing variable **6.** Recognize that centripetal force is a perpendicular force that keeps objects moving in a circle and can include forces previously chapters **7.** Develop the appropriate equation for a moving object located at various points on a vertical circle	8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2), RST.9-10.1 through 10 or RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.2.12.E.2**, 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-CN.1, 4, 6, N-Q.1, 2, 3, N-VM.1, 4, 5, RST.9-10.1, 2, 3, 4 OR RST.11-12.1, 2, 3, 4, **5.2.12.E.3**, 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, RST.9-10.1, 2, 3, 4 OR RST.11-12.1, 2, 3, 4, **5.2.12.E.4**, 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-CN.1, 4, 6, N-Q.1, 2, 3, N-VM.1, 4, 5, RST.9-10.1, 2, 3, 4 OR RST.11-12.1, 2, 3, 4 **2. 5.1.12.A.1, 5.2.12.E.2** **3. 5.1.12.A.1, 5.2.12.E.2** **4. 5.1.12.A.1, 5.2.12.E.2** **5. 5.1.12.A.1, 5.2.12.E.2, 5.2.12.E.3, 5.2.12.E.4** **6. 5.1.12.A.1, 5.2.12.E.2, 5.2.12.E.3, 5.2.12.E.4** **7. 5.1.12.A.1**, **5.1.12.A.2**, **5.2.12.E.2**, **5.2.12.E.3, 5.2.12.E.4**

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Most concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance.

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures, Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate them. Students will also write explanations with diagrams for time dependent labs.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Students will work with/investigate concepts through laboratory investigation including:

- Using ultrasonic motion sensors to measure and determine the relationships between position, velocity and time.
- Movie cameras and motion capture software to analyze the motion of an object.
- PhET simulations/Gizmos to discover basics of how objects move.
- Various demonstrations of phenomena such as falling apples to illustrate various points.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a “Unit in Review” poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a “How It Works” project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/06 Uniform Circular Motion folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. {K, C, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Performance Assessments:

Students will be required to turn in homework, and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 7 – Work and Energy

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/Work and Energy** **Grade Level(s):** **11-12**	**Unit Summary**: This unit will explore the concepts of work and energy and will examine their relationship. Work is defined as the product of a force that pushes an object through a distance. Alternatively, work is defined as a change in energy of a defined system. Energy is always conserved in any defined system and can be converted into any of a variety of forms including mechanical energy, heat, light, and sound. Energy can be defined as the ability to do work. Mechanical energy is described as energy associated with the motions or position of large scale objects. In this unit, three forms of mechanical energy will be examined: kinetic energy, gravitational potential energy, and elastic potential energy. Forces that are conservative have potential energies associated with them and will not change the total mechanical energy of a system, regardless of the path that was taken as the objects changed their positions. Examples of conservative forces include gravity, elastic, and electrical forces. When these types of forces are the only forces acting on a system, the law of conservation of mechanical energy can be applied. Non-conservative forces are forces in which the path that the object takes will affect the amount of work done on the system. Because work is performed, the mechanical energy of the system is changed and therefore the law of conservation of mechanical energy cannot be applied. Total energy will still be conserved, but the other forms of non-mechanical energy will need to be considered and will go beyond the scope of this course. The area under a force-position graph curve is equal to the work done on a system.
Essential Question(s): • What are work, energy and power and how are they related? • How many kinds of energy are there? • Why do things on the top of mountains have more mechanical energy than things at sea level? • How can it be argued that	**Enduring Understanding(s):** • A system is an object or collection of objects. Objects are treated as having no internal structure • A force exerted through a distance (work) on an object can change the kinetic energy of the object • Only the parallel component of the net force exerted on an object will increase or decrease the kinetic energy of the object • Perpendicular forces can change the direction of an object without changing the object's kinetic energy (circular, projectile motion)

"most of the energy on the Earth came from the Sun" • Do moving objects have more energy than stationary objects? • What is the relationship for the interchange of energy? • How do roller coasters work?	• The energy of a system includes its kinetic energy, potential energy, and microscopic internal energy. Interactions with other objects or systems can change the total energy of a system • Mechanical energy of a system is changed when work is performed on the system • Work can be found from the area under a graph of the magnitude of the force component parallel to the displacement versus displacement • Absent non-conservative forces (friction, thrust, etc), mechanical energy is conserved in a system • A system is defined by the observer and should account for all objects involved in an interaction • Potential energy is only associated with conservative forces (elastic, gravitational) • The work done by a conservative force is independent of the path taken • Power is defined as the rate of energy transfer into, out of, or within a system

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	**NJCCCS or CCS**
1. Use force and velocity vectors to determine qualitatively or quantitatively the net force exerted on an object and whether kinetic energy of that object would increase, decrease, or remain unchanged (target identified by AP Central) **2.** Define and state the equations for kinetic energy, gravitational potential energy and elastic potential energy **3.** Calculate the change in kinetic energy of an object given the forces on the object and the displacement of the object (target identified by AP Central) **4.** Identify the types of energy and calculate the total energy as an object moves through a system **5.** Predict changes in the total energy of a system due to changes in position and speed of objects or frictional interactions within the system (target identified by AP Central) **6.** Explain the difference between a conservative and non-conservative force **7.** Make predictions about the changes in the mechanical energy of a system when a component of an external force acts parallel or antiparallel to the direction of the displacement of the center of mass (target identified by AP Central) **8.** Explain the physical meaning when positive, negative or zero work is performed on a system **9.** Apply the work-energy theorem to determine changes in potential, kinetic and mechanical energy when non-conservative forces are present **10.** Apply the law of conservation of energy to determine changes in potential, kinetic and mechanical energy when only	**1. 5.1.12.A.1**, 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2), RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.2.12.E.3:** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, RST.9-10.1, 2, 3, 4 OR RST.11-12.1, 2, 3, 4 **2. 5.1.12.A.1, 5.2.12.D.1,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, RST.11-12.1, 2, 3, 4 **3. 5.1.12.A.1** **4. 5.1.12.A.1** **5. 5.1.12.A.1, 5.2.12.D.1** **6. 5.1.12.A.1** **7. 5.1.12.A.1, 5.2.12.E.3** **8. 5.1.12.A.1** **9. 5.1.12.A.1, 5.2.12.D.1** **10. 5.1.12.A.1, 5.2.12.D.1** **11. 5.1.12.A.1, 5.2.12.D.1**

conservative forces are present **11.** Make qualitative predictions and quantitative calculations of the internal potential energy of a system from a description or diagram of that system (target identified by AP Central) **12.** Analyze experimental data to examine how a force exerted on an object or system does work on the object or system as it moves through a distance (target identified by AP Central) **13.** Analyze graphical data in which interpretations of the area under a force-distance curve are needed to determine the work done on or by the object or system (target identified by AP Central) **14.** Explain how an external force does work on a system therefore changing its total internal energy **15.** Define power as the rate at which work is done **16.** Derive at least two expressions for power	**12. 5.1.12.A.1, 5.1.12.B.4,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 9.1.12.A.1, 9.1.12.B, 9.4O, RST.11-12.1 through 10, WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **13. 5.1.12.A.1, 5.1.12.B.4** **14. 5.1.12.A.1, 5.2.12.D.4,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, RST.9-10.1, 2, 3, 4 OR RST.11-12.1, 2, 3, 4, **5.2.12.E.3** **15. 5.1.12.A.1** **16. 5.1.12.A.1**

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. The concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance**.**

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures, Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate them. Students will also write explanations with diagrams for time dependent labs.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a "Unit in Review" poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a "How It Works" project using HowStuffWorks.com and concepts that were presented in the unit
Students might reinforce understanding by creating a "How It Works" project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/07 Work-Energy folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:
Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. {K, C, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:
Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics coverered.

Performance Assessments:

Students will be required to turn in homework and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:
Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered.

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 8 – Impulse and Momentum

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/Impulse-Momentum** **Grade Level(s):** **11-12**	**Unit Summary**: This unit will examine the concepts of momentum and impulse. Momentum is the product of an object's mass and velocity. The total momentum of a closed system is always conserved and can therefore be used to predict the motion of objects before or after a collision. When an object imparts a force on another object, the total momentum of the objects will be changed. A change in an object's momentum is called impulse and is the product of the average force that is imparted on an object and the duration in which the force was applied. The area under a force-time graph is equal to the impulse imparted on an object. This unit will also look at quantities that are conserved in collisions between objects within a system. While it is true that momentum and total energy are always conserved in these interactions, mechanical energy is not. In an elastic collision, molecular and atomic arrangements of the objects involved in the interaction are not altered and therefore, mechanical energy will be conserved. In an inelastic collision, energy is needed to alter the molecular and atomic arrangement within the system, thereby altering the total kinetic energy of the system.
Essential Question(s): • How can I describe the motion of objects as they interact? • What is momentum? • Is momentum a vector? • Is an impulse just something I do on a whim? • What does it mean to "conserve" momentum? • Why do cars have crumple zones?	**Enduring Understanding(s):** • A system is an object or collection of objects. Objects are treated as having no internal structure • Momentum is a vector quantity and is the product of mass and velocity • A force exerted on an object can change the momentum of the object • The change in momentum of that object depends on the impulse, which is the product of the average force and the time interval during which the interaction occurred • The force that one object exerts on a second object changes the momentum of the second object and can change the total momentum of a system • Momentum can be determined from the area under the force-time graph • The changes in linear momentum and force are both vectors in the same direction • Absent external forces momentum is conserved in a closed system

	• In a closed system, the kinetic energy after an elastic collision is the same as the kinetic energy before the collision • In a closed system, the kinetic energy after an inelastic collision is different from the kinetic energy before the collision • When objects in a system collide, the velocity of the center of mass of the system will not change unless an external force is exerted on the system

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target	**NJCCCS or CCS**
1. Select and apply the appropriate relationship for relating changes in momentum of an object, average force, impulse, and time of interaction (target identified by AP Central) **2.** Define momentum as a product of a system's mass and velocity **3.** Define impulse as the product of a system's average force and the time during which the force is applied **4.** Analyze graphical data to determine the change in momentum of an object from the average force exerted on the object and the interval of time during which the force is exerted (target identified by AP Central) **5.** Design a plan for collecting data to investigate the relationship between changes in momentum and the average force exerted on an object over time (target identified by AP Central) **6.** Calculate the change in linear momentum of a two-object system with constant mass (data, graphs, etc.) (target identified by AP Central) **7.** Analyze data to find the change in linear momentum for a constant-mass system using the product of the mass and the change in velocity of the center of mass (target identified by AP Central) **8.** Make qualitative predictions about natural phenomena based on conservation of linear momentum and restoration of kinetic energy in elastic collisions (target identified by AP Central) **9.** Make qualitative predictions about natural phenomena based on conservation of linear momentum and changes in kinetic energy in inelastic collisions (target identified by AP Central) **10.** Design an experiment to verify the principle of conservation of momentum **11.** Solve for variables involving elastic and inelastic collisions **12.** Discuss the similarities and differences between elastic and inelastic collisions **13.** Devise a plan to collect data to test the law of conservation of momentum in a two-object collision that is elastic or inelastic	**1.** **5.1.12.A.1,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2), RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.2.12.E.3,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, RST.11-12.1, 2, 3, **5.2.12.E.4,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, RST.11-12.1, 2, 3, 4 **2.** **5.1.12.A.1** **3.** **5.1.12.A.1**, **5.2.12.E.3, 5.2.12.E.4** **4.** **5.1.12.A.1, 5.1.12.B.4,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 9.1.12.A.1, 9.1.12.B, 9.4O, RST.11-12.1 through 10, WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.2.12.E.3, 5.2.12.E.4** **5.** **5.1.12.A.1, 5.1.12.B.1,** 2.2.12.B.1, 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 9.1.12.A.1, 9.1.12.B, 9.4O, RST.11-12.1 through 10, WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.1.12.B.4**

and analyze the resulting data graphically (target identified by AP Central) **14.** Calculate the energy lost in an inelastic collision **15.** Analyze data to verify conservation of momentum in collisions with and without an external friction force (target identified by AP Central) **16.** Recognize that interactions within the system have no effect on the motion of the center of mass of the system	**6. 5.1.12.A.1**, **5.1.12.B.4** **7. 5.1.12.A.1**, **5.1.12.B.4** **8. 5.1.12.A.1**, **5.2.12.D.4,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, RST.11-12.1, 2, 3, 4 **9. 5.1.12.A.1**, **5.2.12.D.4** **10. 5.1.12.A.1**, **5.1.12.B.1**, **5.2.12.B.4** **11. 5.1.12.A.1**, **5.2.12.D.4** **12. 5.1.12.A.1**, **5.2.12.D.4** **13. 5.1.12.A.1**, **5.1.12.B.1**, **5.2.12.B.4** **14. 5.1.12.A.1**, **5.2.12.D.4** **15. 5.1.12.A.1**, **5.2.12.B.4** **16. 5.1.12.A.1**

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Most concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance.

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures, Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate them. Students will also write explanations with diagrams for time dependent labs

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a "Unit in Review" poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a "How It Works" project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/08 Impulse-Momentum folder for quizzes, labs and activities. {K, C, Ap, An, S, E}
-

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered.

Performance Assessments:

Students will be required to turn in homework, and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 9 – Rotational Kinematics

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/Rotational Kinematics** **Grade Level(s):** **11-12**	**Unit Summary**: For every linear motion equation and principle there is a rotational counterpart. This unit will investigate the laws of motion for objects along a circular path without referring to the forces causing the motion. Rotational kinematics can be described in terms of angular displacement, angular velocity, and angular acceleration to describe rotational motion and are analogous to terms used to describe linear motion. The underlying theme of this unit is to relate concepts for linear motion to rotational motion. Angular displacement is the angle swept out by a line passing through any point in the body and intersecting the axis of rotation perpendicularly for a rigid body rotating about a fixed axis. Angular velocity and acceleration are defined using relationships analogous to those for their linear counterparts. Tangential velocity is the linear velocity of a point on a rigid rotating body at a distance from the axis of rotation and tangential acceleration is the linear acceleration of a point on a rotating rigid object. Angular variables will be used to derive relationships for tangential velocity and acceleration. Tangential acceleration is used to describe non-uniform circular motion when an object is experiencing a force in the tangential direction as well as a centripetal force. A point on an object rotating in non-uniform circular motion experiences a total acceleration that is the vector sum of the tangential and centripetal accelerations. Finally, these concepts will be related to rolling objects. The essence of rolling motion is that there is no slipping at the point where the object is in contact with the surface upon which it is rolling. The tangential speed of a point on the outer edge is equal to the linear speed of the object parallel to the surface. Similarly the magnitudes of the tangential and linear accelerations are equal as well.
Essential Question(s): • How does linear motion relate to rotational motion? • How is rotational motion transferred to linear motion? • How are rotational velocity and acceleration different	**Enduring Understanding(s):** • Translational and rotational motion are analogous • Objects rotating about a fixed axis experience rotational kinematics • Angular acceleration and angular acceleration are vectors and can be characterized as positive or negative depending upon whether they correspond to clockwise or counterclockwise rotation • Angular velocity and acceleration is found by determining angular changes

from linear velocity and acceleration?	with respect to time, using degrees or radians

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target: Students will be able to…	**NJCCCS or CCS:**
1. Use mathematical equations to represent the relationship between force and torque (target identified by AP Central) **2.** Rank the torques created by a variety of combinations of forces and lever arms on an object **3.** Design an experiment to determine a relationship between torques in a balanced rigid system (target identified by AP Central) **4.** Given a diagram, calculate torques on a two-dimensional system in static equilibrium (target identified by AP Central) **5.** Make predictions about the change in the angular velocity about an axis for an object when forces exerted on the object cause a torque about that axis (target identified by AP Central) **6.** Plan data collection and analysis strategies designed to test the relationship between a torque exerted on an object and the change in angular velocity of that object about an axis (target identified by AP Central) **7.** Interpret and explain the relationships among an object's rotational displacement, velocity, and acceleration **8.** Describe the analogous relationship between translational and rotational motion **9.** Use the right-hand rule to associate an angular velocity vector with a rotating object **10.** Determine angular acceleration for a rigid body which rotates about a fixed axis with a specified external force **11.** Determine tangential acceleration of a point on a rigid body **12.** Apply relationships between translation and rotational motion to rolling objects	**1. 5.1.12.A.1,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2 RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **5.2.12.E.2** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-CN.1, 4, 6, N-Q.1, 2, 3, N-VM.1, 4, 5, RST.11-12.1, 2, 3, 4**, 5.2.12.E.3** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, RST.11-12.1, 2, 3, 4; **2. 5.1.12.A.1, 5.2.12.E.2, 5.2.12.E.3** **3. 5.1.12.A.1, 5.1.12.B.1,** 2.2.12.B.1, 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 9.1.12.A.1, 9.1.12.B, 9.4O, RST.11-12.1 through 10, WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **5.2.12.E.2, 5.2.12.E.3** **4. 5.1.12.A.1, 5.2.12.E.2, 5.2.12.E.3** **5. 5.1.12.A.1** **6. 5.1.12.A.1, 5.1.12.B.1, 5.2.12.E.2, 5.2.12.E.3** **7. 5.1.12.A.1,5.2.12.E.1** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, A-REI.3, 6, RST.11-12.1, 2, 3, 4; **8. 5.1.12.A.1,5.2.12.E.2**

	9. **5.1.12.A.1** 10. **5.1.12.A.1,5.2.12.E.1, 5.2.12.E.2** 11. **5.1.12.A.1,5.2.12.E.1, 5.2.12.E.2** 12. **5.1.12.A.1,5.2.12.E.1, 5.2.12.E.2**

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Most concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance.

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures, Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate them. Students will also write explanations with diagrams for time dependent labs.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a "Unit in Review" poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a "How It Works" project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/09 Rotational Kinematics folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:
Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. {R, U, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:
Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Performance Assessments:

Students will be required to turn in homework and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:
Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 10 – Rotational Dynamics

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/ Rotational Dynamics** **Grade Level(s):** **11-12**	**Unit Summary**: This unit will utilize concepts for rotational dynamics that are analogous to concepts used in linear dynamics. The role of force in linear dynamics will be related to the role of torque in rotational dynamics. The investigation of rotational dynamics begins with an examination of torque and how it acts on a rotating object. Torque has a magnitude of force times the perpendicular distance between the line of action and the axis of rotation. A rigid body is in rotational equilibrium if the net force and net torque are both zero. Torque is produced by the weight of a rigid object and is located at its center of gravity. Net torque is directly proportional to angular acceleration. Moment of inertia is the rotational equivalent of mass and depends on the arrangement of the particles and their distance from the rotational axis. Moment of inertia is used to calculate net torque, angular momentum and rotational kinetic energy. Just as there are rotational variables that are analogous to linear variables for displacement, velocity, acceleration, mass and force, there are also rotational terms for energy and momentum. Like their translational counterparts, the laws conservation of energy and momentum apply to rotating objects.
Essential Question(s): • What is torque? • How do forces and torques affect the motion of rigid bodies? • What conditions are necessary for an object to be in rotational equilibrium? • How is the center of gravity determined for a rigid object? • How does Newton's second law apply to rotational motion? • How do work and energy apply to rotational motion?	**Enduring Understanding(s):** • Only the force component perpendicular to the line connecting the axis of rotation and the point of application of the force results in a torque about that axis • The lever arm is the perpendicular distance from the axis of rotation or revolution to the line of application of the force • Torque is the product of lever arm and force • The net torque is zero at rotational equilibrium • A net torque will cause angular acceleration and change angular momentum • Rotational motion can be described in terms of angular displacement, angular velocity, and angular acceleration about a fixed axis • The direction of rotational vectors are clockwise (-) and counterclockwise (+) • Angular momentum is a vector quantity, with its direction determined by a right-hand rule • The angular momentum of a point about an axis is the product of the

• What is the moment of inertia? • What is angular momentum? • Is angular momentum conserved?	perpendicular distance from the axis of rotation to the line of motion and the linear momentum • The angular momentum of an extended object is the product of rotational inertia and the angular velocity • The change in angular momentum of an object is given by the product of the average torque and the time the torque is exerted • The angular momentum of a system is conserved • The angular momentum of a system may change due to interactions with other objects or systems • The change in angular momentum is given by the product of the average torque and the time interval during which the torque is exerted • The rotational inertia of an object or system depends upon the distribution of mass within the object or system. Changes in the radius of a system or in the distribution of mass within the system result in changes in the system's rotational inertia

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target: Students will be able to…	**NJCCCS or CCS:**
1. Describe the analogy between fixed axis rotations and straight line translation 2. State that torque, moment of a force, is calculated by the product of the force and perpendicular distance between the axis of rotation and the line of action of force 3. State the equation for torque and be able to calculate the torque produced on a system by a given force 4. Apply translational and rotational conditions of equilibrium in solving problems involving rotational equilibrium 5. Calculate the magnitude and direction of the torque associated with a given force 6. Plan data collection and analysis strategies designed to test the relationship between torques exerted on an object and the change in angular momentum of that object (target identified by AP Central) 7. Analyze a situation in which several forces exerted on a rotating system of rigidly connected objects change the angular velocity and angular momentum of the system (target identified by AP Central) 8. Develop a procedure to predict torque, angular velocity, angular acceleration, and angular momentum of a rotating object (target identified by AP Central) 9. Analyze a situation in which angular momentum changes due to interaction with other objects or systems (target identified by AP Central) 10. Experimentally determine the change in angular momentum of a system and relate it to interactions with other objects and systems (target identified by AP Central)	1. **5.1.12.A.1,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2), RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **5.2.12.E.1,** 3.1G, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1 A, 8.1A, 8.1F, 8.2B, 9.1A, 9.1B, 9.1C, 9.1D, 9.1E, 9.4A, 9.4O, 9.4 O(1), 9.4O(2), **5.2.12.E.2,** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 8.2B, 9.1A, 9.1B, 9.1C, 9.1D, 9.1E, 9.4A, 9.4O, 9.4 O(1), 9.4O(2) **2. 5.1.12.A.1, 5.2.12.E.2** **3. 5.1.12.A.1, 5.2.12.E.2** **4. 5.1.12.A.1, 5.2.12.E.2** **5. 5.1.12.A.1, 5.2.12.E.2** 6. **5.1.12.A.1, 5.1.12.B.1,** 3.1G, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 8.2A,

11. Calculate values for initial or final angular momentum, or change in angular momentum of a system, or average torque or time during which torque is exerted (target identified by AP Central) 12. Develop a procedure to test the relationship between the change in angular momentum of a system and the product of the average torque applied to the system and the time interval during which the torque is exerted (target identified by AP Central) 13. Make qualitative and quantitative predictions about the angular momentum of a system for a situation in which there is no net external torque (target identified by AP Central) 14. Describe or calculate the angular momentum and rotational inertia of a system in terms of the locations and velocities of objects that make up the system (target identified by AP Central)	8.2B, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.1.12.B.2,** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2)**, 5.1.12.B.3,** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.1.12.B.4** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.2.12.E.2** 7. **5.1.12.A.1, 5.2.12.E.2** 8. **5.1.12.A.1, 5.1.12.B.1, 5.1.12.B.2, 5.1.12.B.3, 5.1.12.B.4, 5.2.12.E.2** 9. **5.1.12.A.1, 5.2.12.E.2** 10. **5.1.12.A.1, 5.1.12.B.1, 5.1.12.B.2, 5.1.12.B.3, 5.1.12.B.4, 5.2.12.E.2** 11. **5.1.12.A.1, 5.2.12.E.2** 12. **5.1.12.A.1, 5.1.12.B.1, 5.1.12.B.2, 5.1.12.B.3, 5.1.12.B.4, 5.2.12.E.2** 13. **5.1.12.A.1, 5.2.12.E.2** 14. **5.1.12.A.1, 5.2.12.E.2**

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Most concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance.

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures, Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate them. Students will also write explanations with diagrams for time dependent labs.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a “Unit in Review” poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a “How It Works” project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/10 Rotational Dynamics folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. { R, U, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Performance Assessments:

Students will be required to turn in homework and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 11 – Simple Harmonic Motion and Elasticity

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

<table>
<tr><td>Course/Unit Title:
AP Physics/SHM and Elasticity
Grade Level(s):
11-12</td><td>Unit Summary:

This unit will investigate a special category of motion known as simple harmonic motion (SHM) and its behavior in pendulums and springs. Simple harmonic motion is different from other forms of motion previously discussed in that displacement, velocity, and acceleration are never constant, and are changing in a predictable pattern that when plotted as a function of time, produce a sine curve. The reasons for variable forces affecting the motion of oscillating objects will be examined.

In this unit, investigations will be conducted to determine the factors that are relevant to the SHM of springs (mass, and spring constant) and pendulums (gravity and length).</td></tr>
<tr><td>Essential Question(s):

• How can a spring or pendulum be used to create a basic clock?
• What criteria must be met in order for an object to be considered to be in SHM?</td><td>Enduring Understanding(s):

• Restoring forces can result in oscillatory motion. When a linear restoring force is exerted on an object displaced from an equilibrium position, the object will undergo a special type of motion called simple harmonic motion
• Gravitational force exerted by the Earth contributes to the SHM of a simple pendulum or mass-spring oscillator
• For a spring that exerts a linear restoring force the period of a mass-spring oscillator increases with mass and decreases with spring stiffness
• For a simple pendulum oscillating the period increases with the length of the pendulum
• Minima, maxima, and zeros of position, velocity, and acceleration are features of harmonic motion
• Force and acceleration for any given displacement of an object oscillating on a spring can be calculated
• Motions of pendulums, springs, and waves can be plotted to produce sine curves. Factors such as period, frequency, wavelength and amplitude can be measured using these sine curves

• Forced vibration and resonance can be used to explain the occurrence of large amplitude vibrations in physical systems (Tacoma Narrows Bridge), earthquakes, skyscrapers, and musical instruments</td></tr>
</table>

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target: Students will be able to…	**NJCCCS or CCS**
1. Predict which properties determine the motion of a simple harmonic oscillator and what the dependence of the motion is on those properties (target identified by AP Central) **2.** Develop a procedure to describe the characteristics of the motion of a system undergoing oscillatory motion caused by a restoring force, such as a spring (target identified by AP Central) **3.** Analyze data to determine relationships between gravity, length, period, and frequency of a pendulum **4.** Analyze data to determine relationships between mass, spring constant, period, and frequency of a vibrating spring **5.** Construct qualitative and quantitative explanations of oscillatory behavior given evidence of a restoring force (target identified by AP Central) **6.** Describe the relationship between period and frequency **7.** Explain how to adjust the frequency, phase and amplitude of a sine curve	**1.** **5.1.12.A.1,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2), RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.2.12.E.2,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-CN.1, 4, 6, N-Q.1, 2, 3, N-VM.1, 4, 5, RST.9-10.1, 2, 3, 4 OR RST.11-12.1, 2, 3, 4 **2.** **5.1.12.A.1**, **5.1.12.B.1,** 3.1G, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 8.2A, 8.2B, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.1.12.B.2,** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2)**, 5.1.12.B.3,** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.1.12.B.4** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.2.12.E.2** **3.** **5.1.12.A.1**, **5.2.12.E.2** **4.** **5.1.12.A.1**, **5.2.12.E.2** **5.** **5.1.12.A.1**, **5.2.12.E.2** **6.** **5.1.12.A.1**, **5.2.12.E.2**

	7. 5.1.12.A.1, 5.2.12.E.2

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Most concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance.

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures, Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate them. Students will also write explanations with diagrams for time dependent labs.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a “Unit in Review”

poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a "How It Works" project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/11 SHM and Elasticity folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. {R, U, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Performance Assessments:

Students will be required to turn in homework and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 12 – Waves and Sound

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/Waves and Sound** **Grade Level(s):** **11-12**	**Unit Summary**: This unit will investigate wave motion. Specifically, we will look at its causes, interactions, and how it is manifested in the form of sound. A wave is propagated by a source that is vibrating in SHM and carries energy from one point to another without actually transferring matter itself between the two points. Mechanical waves require a medium to transfer energy. Electromagnetic waves do not require a medium to transfer energy. Waves in which the medium vibrates perpendicular to the wave's motion are called transverse waves, whereas waves in which the medium vibrates parallel to the direction of the wave are considered to be longitudinal. Parts of a wave can be observed and measured (wavelength, amplitude, frequency, and period). The speed of a wave is the product of the frequency and wavelength of the wave. The speeds of waves are influenced by other factors (such as temperature, tension, moving sources) and changing these speeds will influence the wavelength of the wave. The speed of a wave is generally independent and is determined by the characteristics of the medium in which it is travelling through. A sound wave is a longitudinal wave that exhibits all of characteristics and experiences all of the interactions listed above. The speed of a sound wave is influenced by the temperature of the medium that it is travelling in. The perceived change in frequency of sound waves from moving sources is known as the Doppler effect.
Essential Question(s): • How can a spring or pendulum be used to create a basic clock? • Why do you see lightning before you hear thunder? • Why must engineers take in account local winds when building large objects such as bridges and skyscrapers? • How do noise cancelling headphones work? • Why do ambulance sirens seem to change sound as	**Enduring Understanding(s):** • Properties of mechanical and electromagnetic waves can be used to explain natural phenomena and technological applications (i.e. thunder before lightning, antennas for cell phone transmission and reception, noise cancellation, musical instruments, decibel-hearing loss, Doppler-radar, echo location /sonography and ultrasound) • Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena • Waves can propagate via different oscillation modes such as transverse and longitudinal • Mechanical waves can be either transverse or longitudinal • For propagation, mechanical waves require a medium, while electromagnetic waves do not require a physical medium

they move? • Why must instruments be re-tuned after warming up?	• The amplitude is the maximum displacement of a wave from its equilibrium value • Classically, the energy carried by a wave depends upon and increases with amplitude • A periodic wave is one that repeats as a function of both time and position and can be described by its amplitude, frequency, wavelength, speed, and energy • For a periodic wave, period is the repeat time of the wave and frequency is the number of repetitions of the wave per unit time • For a periodic wave, wavelength is the repeat distance of the wave and is the ratio of speed over frequency • The observed frequency of a wave depends on the relative motion of source and observer

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target: Students will be able to…	**NJCCCS or CCS**
1. Distinguish between transverse and longitudinal waves using visual representations (target identified by AP Central) 2. Describe representations of transverse and longitudinal waves (target identified by AP Central) 3. Describe sound as a transfer of energy and momentum periodically in a medium and relate the concepts to everyday examples (target identified by AP Central) 4. Use graphical representation of a periodic mechanical wave to determine the amplitude, wavelength, period, and frequency of the wave (target identified by AP Central) 5. Describe how a change in the frequency would modify features of a visual representation of a wave (target identified by AP Central) 6. Explain and predict qualitatively how the energy carried by a sound wave relates to the amplitude of the wave and apply this concept to a real-world example (target identified by AP Central) 7. Design an experiment to determine the relationship between periodic wave speed, wavelength, and frequency and relate these concepts to everyday examples (target identified by AP Central) 8. Explain factors that affect the speed of sound in different media 9. Calculate the speed of sound in various media 10. Define intensity of a sound wave and calculate intensity levels	1. **5.1.12.A.1,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2), RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.2.12.E.2,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-CN.1, 4, 6, N-Q.1, 2, 3, N-VM.1, 4, 5, RST.9-10.1, 2, 3, 4 OR RST.11-12.1, 2, 3, 4 2. **5.1.12.A.1, 5.2.12.E.2** 3. **5.1.12.A.1, 5.2.12.E.2** 4. **5.1.12.A.1, 5.2.12.E.2** 5. **5.1.12.A.1, 5.2.12.E.2** 6. **5.1.12.A.1, 5.2.12.E.2** 7. **5.1.12.A.1, 5.1.12.B.1,** 3.1G, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 8.2A,

of sound 11. Describe Doppler Effect and apply relationships in solving for observed frequency of a moving source of sound	8.2B, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.1.12.B.2,** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2)**, 5.1.12.B.3,** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.1.12.B.4** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.2.12.E.2** **8. 5.1.12.A.1, 5.2.12.E.1,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-Q.1, 2, 3, A-REI.3, 6, RST.9-10.1, 2, 3, 4 OR RST.11-12.1, 2, 3, 4, **5.2.12.E.2** **9. 5.1.12.A.1, 5.2.12.E.1** **10. 5.1.12.A.1** **11. 5.1.12.A.1, 5.2.12.E.2**

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Most concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance.

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures, Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate them. Students will also write explanations with diagrams for time dependent labs.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a “Unit in Review” poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a “How It Works” project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/12 Waves and Sound folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. { R, U, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old

AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Performance Assessments:

Students will be required to turn in homework and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 13 – Wave Superposition

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/Wave Superposition** **Grade Level(s):** **11-12**	**Unit Summary**: When multiple waves occupy one space at the same time, they interfere with each other. This interaction between waves in such a way is known as wave superposition and can produce several effects. When a wave strikes a boundary, it may reflect off the boundary (in which it will obey the law of reflection), or it may pass through the boundary, but at an altered angle (refraction). When a wave passes through an opening it will spread out (diffract). If a wave encounters another wave, the two waves will interfere. Constructive interference occurs when waves create a bigger wave. Destructive interference occurs when waves create a smaller wave. These interactions can produce standing waves in which…students will look at the concept of resonance (interference) as it applies to musical instruments and their distinct sounds.
Essential Question(s): • How do noise cancelling headphones work? • Why do you sound better in the shower? • Why are concert halls designed the way they are? • Why are instruments shaped the way they are? • Why do troops break stride when marching over a bridge? • What happened to the Tacoma Narrows Bridge? • Why do different instruments sound	**Enduring Understanding(s):** • Only waves exhibit interference and diffraction • Interference and superposition lead to standing waves and beats • Two or more wave pulses can interact in such a way as to produce amplitude variations in the resultant wave • When two pulses cross, they travel through each other; they do not bounce off each other • When wave pulses are superimposed the resulting displacement can be determined by adding the displacements of the two pulses • Standing waves are the result of the addition of incident and reflected waves that are confined to a region and have nodes and antinodes • Standing waves of a particular frequency can only have distinct wavelengths and are determined by the size of the region to which they are confined. • Frequencies that produce standing waves are called fundamental frequencies and harmonics • Beats arise from the addition of waves of slightly different frequency. • The beat frequency is the difference in frequency between the two waves

different?	

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target: Students will be able to…	**NJCCCS or CCS**
1. Use representations of individual pulses to predict the interaction and analyze the superposition of wave pulses (target identified by AP Central) **2.** Design an experiment and analyze data illustrating the superposition of mechanical waves (only for wave pulses or standing waves) (target identified by AP Central) **3.** Design an experiment to quantify the amplitude variations when two or more traveling waves or wave pulses interact in a given medium (target identified by AP Central) **4.** Analyze the interaction of two or more traveling waves in one or two dimensions (i.e., circular wave fronts) to evaluate the variations in resultant amplitudes (target identified by AP Central) **5.** Develop and perform a procedure and use observations to qualitatively describe standing wave phenomena (i.e. whole number multiple of frequencies to generate more "loops") (target identified by AP Central) **6.** Describe and predict properties of standing waves that result from the addition of incident and reflected waves that are confined to a region and have nodes and antinodes (target identified by AP Central) **7.** Develop an experiment to determine variables responsible for establishing standing waves on a string or in a column of air (target identified by AP Central) **8.** Develop an experiment to test the claim that the wavelengths of standing waves are determined by the frequency of the source regardless of the size of the region (target identified by AP Central) **9.** Calculate wavelengths and frequencies (if given wave speed) of standing waves based on boundary conditions and length	**1.** **5.1.12.A.1,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2), RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.2.12.E.2,** 8.1.12.A.1, 2, 9.1.12.A.1, 9.1.12.B, 9.4O, N-CN.1, 4, 6, N-Q.1, 2, 3, N-VM.1, 4, 5, RST.9-10.1, 2, 3, 4 OR RST.11-12.1, 2, 3, 4 **2.** **5.1.12.A.1, 5.1.12.B.1,** 3.1G, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 8.2A, 8.2B, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.1.12.B.2,** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2)**, 5.1.12.B.3,** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.1.12.B.4** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.2.12.E.2** **3.** **5.1.12.A.1, 5.1.12.B.1, 5.1.12.B.2, 5.1.12.B.3, 5.1.12.B.4**, **5.2.12.E.2** **4.** **5.1.12.A.1, 5.2.12.E.2**

of region within which the wave is confined (target identified by AP Central) **10.** Use a visual representation to explain how waves of slightly different frequency give rise to the phenomenon of beats (target identified by AP Central) **11.** Explain why resonance occurs and how musical instruments use resonance to produce music	**5. 5.1.12.A.1, 5.1.12.B.1, 5.1.12.B.2, 5.1.12.B.3, 5.1.12.B.4, 5.2.12.E.2** **6. 5.1.12.A.1, 5.2.12.E.2** **7. 5.1.12.A.1, 5.1.12.B.1, 5.1.12.B.2, 5.1.12.B.3, 5.1.12.B.4, 5.2.12.E.2** **8. 5.1.12.A.1, 5.1.12.B.1, 5.1.12.B.2, 5.1.12.B.3, 5.1.12.B.4, 5.2.12.E.2** **9. 5.1.12.A.1, 5.2.12.E.2** **10. 5.1.12.A.1, 5.2.12.E.2** **11. 5.1.12.A.1, 5.2.12.E.2**

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Most concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance**.**

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures. Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate it.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

<u>How</u> will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a "Unit in Review" poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a "How It Works" project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

<u>Formative Assessments</u>:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/13 Wave Superposition folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. { R, U, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered

Performance Assessments:

Students will be required to turn in homework and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP

Physics review material as further enrichment resources for all topics covered.

Black Horse Pike Regional School District Curriculum Template

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

AP Physics Curriculum

Unit 14 – Introduction to Electric Circuits

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: **AP Physics/Intro to Electric Circuits** **Grade Level(s):** **11-12**	**Unit Summary**: Conservation laws are one of the most important and fundamental concepts in physics. This unit will be an introduction to the application of these laws in terms of electricity. In particular, this unit will look at the laws of conservation of energy and electric charge as applied to electrical circuits. The rules that address these two fundamental laws are explained by Kirchoff's rules. The loop rule is a restatement of the law of conservation of energy in that the sum of the potential rises in an electrical loop must equal the sum of the potential drops in a circuit. The junction rule is a restatement of the law of conservation of charge in that total current (charge) entering a junction must equal the total current exiting the junction. In order to address these rules, certain electrical terms must be discussed. Resistivity is a property of matter and depends upon several factors. Resistivity and other factors can be used to determine the resistance of an object. Electric potential is a measurement of potential energy per unit of charge. Current is the amount of charge that flows through a material in a given period of time. Resistance, current, and potential difference are related by Ohm's Law and states that potential difference is the product of resistance and current. All resistors in electric circuits are governed by Ohm's Laws. Electric circuits are pathways for electric current to follow and can be wired in series (one path for current), parallel (multiple paths for current), or a combination of the two. Each of these circuits will be analyzed in terms of conservation of energy and charge. Energy that is carried by electrical charges through different devices in circuits can be converted into various forms of energy introduced in other units that are covered in this course (mechanical, sound, heat, or light).
Essential Question(s): • How is Kirchoff's loop rule simply a restatement of the law of conservation of energy? • How is Kirchoff's junction rule simply a restatement of the law of conservation of charge?	**Enduring Understanding(s):** • Materials have many macroscopic properties that result from the arrangement and interactions of the atoms and molecules that make up the material • Matter has a property called resistivity • The resistivity of a material depends on its molecular and atomic structure • The resistivity depends on the temperature of the material • Kirchhoff's loop rule describes conservation of energy in electrical circuits • Energy changes in simple electrical circuits are conveniently represented in terms of energy change per charge moving through a battery and a resistor • Since electric potential difference times charge is energy, and energy is

• How is Ohm's Law used to determine current, voltage, or resistance of a resistor? • What factors affect the resistivity of a material? • What factors affect the resistance of a wire? • How does the energy from a battery create light in a light bulb and why would multiple bulbs behave differently in series and parallel? • Why is it dangerous to plug large current appliances into an inappropriate extension cord? • Why are some circuits wired in series while others, like your bedroom, are wired in a parallel arrangement?	conserved, the sum of the potential differences about any closed loop must add to zero • The electric potential difference across a resistor is given by the product of the current and the resistance • The rate at which energy is transferred from a resistor is equal to the product of the electric potential difference across the resistor and the current through the resistor • The electric charge of a system is conserved • Kirchhoff's junction rule describes the conservation of electric charge in electrical circuits. Since charge is conserved, current must be conserved at each junction in the circuit. • Circuits can combine resistors in series, parallel, or both

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

After each target, identify the NJCCCS or Common Core Standards that are applicable

Learning Target: Students will be able to…	**NJCCCS or CCS**
1. Make claims about natural phenomena based on conservation of electric charge (target identified by AP Central) **2.** Make qualitative and quantitative predictions about the charge of an object or system using the conservation of electric (target identified by AP Central) **3.** Construct an explanation of the two-charge model of electric charge based on evidence produced through scientific practices (target identified by AP Central) **4.** Challenge the claim that an electric charge smaller than the elementary charge has been isolated (target identified by AP Central) **5.** Choose and justify the selection of data needed to determine resistivity for a given material (target identified by AP Central)	**1. 5.1.12.A.1,** 8.1.12.A, 8.1.12.C, 8.1.12.D, 8.1.12.E, 8.1.12.F, 8.2.12.F, 8.2G, 9.1.12.A.1, 9.1.12.B, , 9.1F, 9.4O, 9.4O(2), RST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **2. 5.1.12.A.1** **3. 5.1.12.A.1** **4. 5.1.12.A.1** **5. 5.1.12.A.1** **6. 5.1.12.A.1** **7. 5.1.12.A.1**

6. State and apply Ohm's Law and define resistance in terms of voltage and current **7.** Construct or interpret a graph of the energy changes within a simple electrical circuit as an application of the conservation of energy (Kirchhoff's loop rule) (target identified by AP Central) **8.** Design an experiment that will demonstrate the validity of Kirchhoff's loop rule ($\Sigma\Delta V = 0$) in a simple circuit (target identified by AP Central) **9.** Apply conservation of energy (Kirchhoff's loop rule) in calculations involving the total electric potential difference for complete circuit loops (target identified by AP Central) **10.** Apply conservation of electric charge (Kirchhoff's junction rule) to the comparison of electric current in various segments of an electrical circuit and predict how those values would change if configurations of the circuit are changed (target identified by AP Central) **11.** Design an investigation of an electrical circuit with one or more resistors in which evidence of conservation of electric charge can be collected and analyzed (target identified by AP Central) **12.** Use a description or schematic diagram of an electrical circuit to calculate unknown values of current in various segments or branches of the circuit (target identified by AP Central)	**8.** **5.1.12.A.1, 5.1.12.B.1,** 3.1G, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 8.2A, 8.2B, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.1.12.B.2,** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2)**, 5.1.12.B.3,** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2), **5.1.12.B.4** 3.1G, 3.1H, 3.2A, 3.2B, 3.2C, 3.2D, 3.5A, 3.5B, 4.1A, 8.1A, 8.1F, 9.1A, 9.1B, 9.1C, 9.4A, 9.4O, 9.4O (1), 9.4O (2) **9.** **5.1.12.A.1** **10.** **5.1.12.A.1** **11.** **5.1.12.A.1, 5.1.12.B.1, 5.1.12.B.2, 5.1.12.B.3, 5.1.12.B.4** **12.** **5.1.12.A.1**

Inter-Disciplinary Connections:

Students will interact with text, and will be asked to read and draw inferences, cite specific evidence, follow procedures/tasks, translate word problems into mathematical problems, and assess text for use in forming arguments or comparing/contrasting arguments. Lab reports will involve technical writing. Students will be expected to write clearly and coherently, revising and editing, and use technology to produce and present their work. Most concepts presented in this unit will incorporate algebra and problem solving skills, as well as vector analysis. Technological advancements (and their impacts on society) utilizing concepts will also be incorporated in this unit. Additionally, the uses of computer technology (Illustrator, Photoshop, LoggerPro, Excel, and possibly Flash) will be used to supplement lessons and investigations. Historical context of discoveries/developments will be addressed as well as their cultural/historical importance**.**

Students will engage with the following text:

Physics: Principles & Applications 7th edition(Pearson), case studies, journal articles, current events

Students will write:

Laboratory investigations will involve a pre-lab write up including purposes and procedures. Lab reports will include a three-paragraph conclusion in which students will restate the purpose, summarize the procedure (identify constants and variables), report results and their significance/meaning, and sources of error and ways to reduce and or eliminate it.

PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

Students will be presented with material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that students have an idea how the factors affect one another.

Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledge

The teacher will model various problems, guide discussion to discovery of concepts, demonstrate specific principles using realia or simulations, offer stories and analogies to make the abstract more concrete, scaffold problem-solving and provide independent practice problems in class and to be reinforced as homework

Students might reinforce concepts learned in the unit by using Photoshop/Illustrator to create a "Unit in Review" poster or Pencast/Video Review lesson

Students might reinforce understanding by creating a "How It Works" project using HowStuffWorks.com and concepts that were presented in the unit

PART IV: EVIDENCE OF LEARNING

IDENTIFY THE METHODS BY WHICH STUDENTS WILL DEMONSTRATE THEIR UNDERSTANDING OF CONTENT AND THEIR ABILITY TO APPLY SKILLS. IDENTIFY BLOOM'S LEVELS. {Note: Letters in red correspond to learning levels indicated in pyramid on the right}

Formative Assessments:

- "Notes Companions" sheets or "Physics Fix" sheets (participation) for students to apply their knowledge by working through concepts through group analysis and problem solving strategies {K, C, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {K, C, Ap, An, S}
- Completion of independent practice worksheets and problem sets {K, C, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps{K, C, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. See District Shared/Science/CURRICULUM WRITING 2013/APPhysics/14 Intro to Electric Circuits folder for quizzes, labs and activities. {K, C, Ap, An, S, E}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered.

Summative Assessments:

Students will be required to take a test to demonstrate proficiency on the material presented in this unit. Tests will ask questions requiring recall of basic concepts and laws, understanding of key concepts as they apply to physical situations, analysis of diagrams, and application and synthesis of multiple mathematical equations to solve for unknown variables. { R, U, Ap, An, S}

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered.

Performance Assessments:

Students will be required to turn in homework and lab reports based on the material in this unit. These assignments will be graded.

Accommodations/Modifications:

Accommodations and, or modifications will be made on a case by case basis in accordance with individual student IEP's including: extended time, step-by-step problem set-up, and alternative evaluation (such as project based assessment)

Enrichment/Enhancement:

Students are given the opportunity for further research on all topics covered in class. They are given access to old AP Physics Exams for examples of questions. Students are also informed and encouraged to use commercial AP Physics review material as further enrichment resources for all topics covered.