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

Introduction

Advanced Placement Physics II is an introductory college level physics course. Designed using the AP Physics II 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 second 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 2015-2016 and changes in the timeline are to be expected).

Proposed Timeline

Weeks 1-2: Review of Physics 1 (5.1.12.A.1, 5.2.12.A.2)
Students will review the major themes of AP Physics I. Major themes that will be addressed will be motion, forces, and energy. This unit will also address the major procedures in experimental design and analysis.

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

Weeks 3-4: Fluids (5.1.12.A.1-3, 5.1.12.B.1-2, 4)
Students will examine and design procedures to predict the behaviors of fluids.

1. Mass density
2. Pressure (dependence on depth, gauge vs absolute)
3. Pascal's Principle
4. Archimedes' Principle
5. Fluid dynamics (equation of continuity, Bernoulli's Principle, viscous flow)

Weeks 5-9: <u>Thermal Physics</u> (5.1.12.A.1-2, 5.1.12.B.1-2, 4, 5.1.12.D2, 5.2.12.C1-2)
Students will examine and design procedures to investigate the concepts of temperature and internal energy. Students will use molecular motion to define and explain temperature and internal energy. The gas laws and the laws of thermodynamics will be applied to explain how heat can be used to perform work. The second half of this unit will place an emphasis on the law of conservation of energy. As this course is developed, it might be advised to break into two units due to amount of content

1. Temperature and temperature scales
2. Thermal expansion (linear and volumetric)
3. Molecular mass and the mole
4. Kinetic molecular theory and the gas laws
5. Heat, work, and internal energy (including PV diagrams)
6. Heat and change (specific heat, latent heat and calorimetry)
7. Methods of heat transfer (conduction, convection, and radiation)
8. Engines and efficiency

Weeks 10-13: <u>Electrostatics and Electric Potential</u> (5.1.12.A.1-2, 5..1.12.D2)
Students will examine the concept of electric charge and the forces and energies associated with electric charges.

1. Conductors and insulators
2. Methods of charging (friction, conduction, and induction)
3. Electric force and Coulomb's law
4. Electric fields and field lines
5. Electric potential energy and the electric potential
6. Capacitance and capacitors (geometry, factors affecting capacitance)

Weeks 14-15: <u>Current Electricity</u> (5.1.12.A.1-2, 5.1.12.B.1-2, 4, 5.1.12.D2)
Students will examine and design procedures to investigate current electricity. In particular, they will examine the factors affecting the amount of current that flows through an electrical conductor as governed by Ohm's law and the electrical power equations. They will also examine, the behavior of electric circuits consisting of varying power sources, resistors, and/or capacitors.

1. Resistance and Ohm's Law
2. Kirchhoff's Rules and electric circuits
3. RC Circuits (steady states)

Weeks 16-17: <u>Magnetism and Electromagnetism</u> (5.1.12.A.1-2)
Students will examine and design procedures to investigate magnetism and electromagnetism. They will use the ideas of magnetism to explain the theory behind ferromagnetism. They will also look at how magnetic forces act upon charges and currents that are moving in magnetic fields. Through demonstration and experimentation, they will gain an understanding of the fact that electric currents can create their own magnetic fields.

1. Magnetic fields and forces (force on moving charges and path of charge)
2. Current in fields (force and torque)
3. Magnetic fields produced by currents
4. Ampere's Law
5. Motional EMF and magnetic flux
6. Faraday's and Lenz's Laws
7. Inductance (Mutual and Self-Inductance)
8. Transformers

Weeks 18-24: Light and Optics (5.1.12.A.1-2, 5.1.12.B.1-2, 4)
Students will examine and design procedures to investigate light and optics.

1. Electromagnetic spectrum, ray optics, polarization, and dispersion
2. Reflection (plane mirrors, spherical mirrors, and mirror equations)
3. Refraction (index of refraction, Snell's Law, and total internal reflection)
4. Lenses (image formation, thin-lenses, and systems of lenses)
5. Optical devices (human eye, telescope, microscope, and lens aberrations)
6. Linear superposition (double-slit experiment, thin-film interference, and interferometer)

Weeks 25-30: Atomic/Nuclear and Modern Physics (5.1.12.A.1-2, 5.1.12.B.1-2, 4, 5.2.12.A4, 5.2.12.D3)
Students will examine and design procedures to investigate concepts in modern and atomic physics.

1. Wave-particle duality (photoelectric effect, Compton effect, blackbody radiation, de Broglie wavelength)
2. Nature of the atom (Rutherford scattering, models of the hydrogen atom)
3. Nuclear physics (nuclear force, binding energy, mass defect)
4. Radioactivity (reactions and energy)
5. Nuclear reactions (fission, fusion, and reactors)
6. Elementary particles and ionizing radiation

Week 30 to AP Exam Date: Exam Review
May-June: Final Project

Course Expectations & Skills

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

Primary Text

Physics: Principles & Applications 7th edition, 2014 Pearson

Grading Scale

Grades are calculated according to the following proportions:
Tests/Quizzes: 50%   Labs/Homework/Classwork: 50%

Black Horse Pike Regional School District Curriculum

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

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: *AP Physics II* *Introduction to Physics II* **Grade Level:** 11/12	**Unit Summary:** This brief unit will be a review of the major concepts, themes, and problem solving approaches that were introduced in the AP Physics I (or Lab Physics A) course. Particular emphasis will be placed on reviewing physical quantities (scalar and vector) and their units, algebra and trigonometry, experimental design and analysis of data, and the relationships between motion, forces, and energy.
Essential Questions: What is the difference between an open and closed system? What is the difference between an object and a system of objects? What is the difference between a scalar and vector quantity? What is meant by the law of conservation of energy? How do forces affect the motion of objects?	**Enduring Understandings:** 1. A system can can be defined when properties of the constituent objects are known 2. A closed system in one in which defined objects cannot enter or leave 3. A vector quantity is a quantity that represents both magnitude and direction. A scalar quantity can only describe magnitude 4. The law of conservation of energy states that energy can never be created or destroyed, but rather changed between various forms (many of which will be addressed for the first time in this course) 5. A net force will cause a change in the motion of an object

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**
Note: all targets are restatements of learning objectives as provided by AP Central. While these targets must be addressed, teachers can feel free to add their own specific targets for each unit. 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 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 3. Construct representations of how the properties of a system are determined by the interactions of its constituent substructure 4. Justify the selection of data relevant to an investigation based on algebraic and physical relationships (to be highlighted in all units)	**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.A2,** 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.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 **2. 5.1.12.A.1, 5.1.12.A2** **3. 5.1.12.A.1, 5.1.12.A2** **4. 5.1.12.A.1, 5.1.12.A2**

Interdisciplinary 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 explore material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and/or 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:

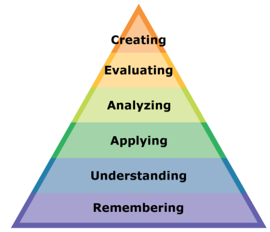
- Using Vernier/Pasco probeware to measure and compare physical variables
- Video Analysis when applicable
- PhET simulations/Gizmos to discover relationships between more abstract variables
- Various demonstrations of phenomena using equipment from room inventory
- Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledges

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

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>:

- "Learning Catalytics" software from Pearson Publishing responders for real-time analysis student understanding {R, U, Ap, An, E}
- Use of Socrative Clicker app and website for warm-up questions and exit tickets for real-time responses {R, U, Ap, An, E}
- 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 {R, U, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {R, U, Ap, An, S}
- Completion of independent practice worksheets and problem sets {R, U, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps {R, U, 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. {R,U, Ap, An, S, E}

<u>Accommodations/Modifications</u>:

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)

<u>Enrichment/Enhancement:</u>

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

<u>Summative Assessments</u>:

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}

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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. Homework will be monitored using MasteringPhysics diagnostic tools (online)

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)

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

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: *AP Physics II* *Fluid Mechanics* **Grade Level:** 11/12	**Unit Summary:** This unit will introduce the concepts of fluids and pressure and their impact on the motion of fluids or objects surrounded by fluids. Students will build upon knowledge of forces and conservation of energy to explain phenomena pertaining to fluids. Students will use an inquiry-based approach to determine relationships (graphical and mathematical) between physical factors pertaining to fluid pressure, Pascal's Principle, Archimedes' Principle, flow continuity, and Bernoulli's Principle.
Essential Questions: What causes pressure to be exerted by a fluid, and why does liquid pressure vary with depth when gas pressure does not? How is the buoyant force generated, and how can this force be mathematically modeled? Why does the buoyant force not vary significantly with depth, even though liquid pressure does? How can conservation of mass and conservation of energy be used to predict the behavior of moving liquids?	**Enduring Understandings:** 1. Density is a property of matter that describes the amount of mass that is contained in a certain amount of space 2. Fluid pressure, but not buoyant force, increases as you move deeper in a fluid 3. External pressure applied to a confined fluid is transmitted throughout the fluid 4. Buoyant force depends on the density of the surrounding fluid and the volume of the object, but not the density of the object 5. An object is buoyed up by a force that is equal to the weight of the fluid that is displaced 6. For an ideal fluid moving through a pipe, the volume flowing into the pipe must be equal to the volume flowing out of the pipe 7. Fast moving fluids are associated with lower pressures than slower moving fluids (same material) 8. Bernoulli's principle is a restatement of the law of conservation of energy

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

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

<u>**Learning Target**</u>	<u>**NJCCCS or CCS**</u>
Note: all targets are restatements of learning objectives as provided by AP Central. While these targets must be addressed, teachers can feel free to add their own specific targets for each unit. 1. Calculate the density of an object given its mass and volume 2. Determine the absolute and gauge pressure of a fluid at varying depths 3. Apply Archimedes' principle to submerged objects to find the buoyant force 4. Experimentally determine the relative densities of various materials 5. Apply Pascal's principle to calculate the output force given a closed hydraulic system 6. Use Bernoulli's equation and/or the continuity equation to make calculations related to a moving fluid 7. Explain Bernoulli's equation in terms of conservation of energy	**1. 5.1.12.A1,** 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.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, **5.1.12.A2,** 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.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 **2. 5.1.12.A1, 5.1.12.A2** **3. 5.1.12.A1, 5.1.12.A2** **4. 5.1.12.A1, 5.1.12.A2, 5.1.12.A3,** 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.9-10.1 through 10 or RST.11-12.1 through 10, WHST.9-10.1 through 10 or WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1**,** **5.1.12.B2,** 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.9-10.1 through 10 or RST.11-12.1 through 10, WHST.9-10.1 through 10 or WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **5.1.12.B4,** 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.9-10.1 through 10 or RST.11-12.1 through 10, WHST.9-10.1 through 10 or WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **5. 5.1.12.A1, 5.1.12.A2** **6. 5.1.12.A1, 5.1.12.A2** **7. 5.1.12.A1, 5.1.12.A2**

Interdisciplinary Connections:

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PART III: TRANSFER OF KNOWLEDGE AND SKILLS

DESCRIBE THE LEARNING EXPERIENCE.

How will students uncover content and build skills.

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

- Density of Beverages Lab
- Fluid Pressure Factors Lab
- Fluid Pressure at Depths Lab (Simulation)
- Buoyant Force Lab
- Siphoning With Bernoulli Lab

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

PART IV: EVIDENCE OF LEARNING

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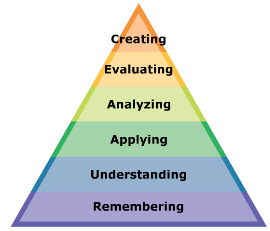

Formative Assessments:

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- 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 {R, U, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {R, U, Ap, An, S}
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Enrichment/Enhancement:

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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}

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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. Homework will be monitored using MasteringPhysics diagnostic tools (online)

Example assessments that are suggested by AP Central include:

- Archimedes' Principle: To determine the densities of a liquid and two unknown objects by using the method that is attributed to Archimedes.
- Torricelli's Theorem: To determine the exit velocity of a liquid and predict the range attained with holes at varying heights using a clear 2 L plastic bottle.
- Water Fountain Lab: The students design an investigation to determine:
  - Exit angle and exit speed of the water
  - Maximum height of water
  - Radius of the fountain's exit hole
  - Flow volume rate

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)

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PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: *AP Physics II* *Thermal Physics* **Grade Level:** 11/12	**Unit Summary:** This unit will introduce the concepts of temperature, heat, and energy and their roles in thermodynamic processes and their impact on the motion of fluids or objects surrounded by fluids. Students will build upon knowledge of work, conservation of energy, and the gas laws (introduced in chemistry) to explain phenomena pertaining to thermodynamics. Students will use an inquiry-based approach to determine relationships (graphical and mathematical) between physical factors pertaining to temperature and expansion, kinetic theory and the gas laws, and the laws of thermodynamics.
Essential Questions: How are heat and temperature explained on a molecular level? How do gas molecules exert pressure on the walls of a container? How is the expansion of a gas related to mechanical work? What is entropy, and how is it related to the irreversibility of most real-world processes?	**Enduring Understandings:** 1. Temperature is a measure of the average translational kinetic energy per molecule in a substance. Absolute zero is the temperature in which the kinetic energy of all molecules is zero 2. Internal energy is the sum of all of the molecular energy in a substance. It is dependent upon temperature and the amount of material 3. Heat is a flow of energy as a result of a temperature difference between two substances 4. The conditions of a gas are related by the equation PV = nRT. When one factor changes, at least one other factor must change with it 5. In general, materials will expand as temperature is increased 6. The three forms of thermal energy transfer are conduction, convection, and radiation and can be explained by the kinetic molecular theory

	7. The states of matter can be explained using the kinetic molecular theory. Changes in state are caused by adding or removing energy that affects molecular motion and attractions 8. The first law of thermodynamics is a restatement of the law of conservation of energy. In a closed system heat, work, and thermal energy can be determined from changes between the three terms 9. The work performed on or by a gas can be determined from the area under a PV curve (and direction in which volume is changing) 10. The second law of thermodynamics says that heat can never flow from a cold material to a hot material spontaneously 11. A heat engine is any device that converts internal energy into work and can never be 100% efficient 12. In all natural processes, order tends to move towards disorder. This term is known as entropy

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
Note: all targets are restatements of learning objectives as provided by AP Central. While these targets must be addressed, teachers can feel free to add their own specific targets for each unit. 1. Relate the average of all kinetic energies of molecules in a system to the temperature of the system 2. Develop a procedure to examine thermal conductivity 3. Determine the direction of heat flow based on molecular motion and/or thermodynamics laws	**1. 5.1.12.A1,** 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.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**,** **5.1.12.A2,** 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,

4. Define pressure in terms of molecular motion and its impact on temperature 5. Calculate the pressure, force, or area for a thermodynamic problem given two of the variables 6. Verify absolute zero given pressure or volume versus temperature data 7. Design a plan to determine the relationships between pressure, volume, and temperature, and amount of an ideal gas 8. Analyze graphical data for an ideal gas to determine the relationships between these variables: PV = nRT 9. Use molecular collisions to explain how a system approaches thermal equilibrium 10. State and apply the first law of thermodynamics in terms of energy conservation 11. Experimentally construct a PV diagram to determine the work done on or by an object or system 12. Plot and analyze a PV diagram for thermodynamic processes from given data 13. Use a PV diagram to determine work, heat, and/or internal energy changes	9.1.12.B, 9.1F, 9.4O, 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.C1,** 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.9-10 or RST.11-12, SL.9-10 or SL.11-12, W.9-10 or W.11-12, WHST.9-10 or WHST.11-12 **2. 5.1.12.A1, 5.1.12.A2, 5.1.12.B1,** 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.9-10.1 through 10 or RST.11-12.1 through 10, WHST.9-10.1 through 10 or WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.1.12.B2,** 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.9-10.1 through 10 or RST.11-12.1 through 10, WHST.9-10.1 through 10 or WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.1.12.B4,** 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.9-10.1 through 10 or RST.11-12.1 through 10, WHST.9-10.1 through 10 or WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **3. 5.1.12.A1, 5.1.12.A2** **4. 5.1.12.A1, 5.1.12.A2** **5. 5.1.12.A1, 5.1.12.A2** **6. 5.1.12.A1, 5.1.12.A2, 5.1.12.C2,** 2.2.12.B.1, 9.1.12.A.1, 9.1.12.B, 9.4O, L.9-10. 5, 6 or L.11-12. 5, 6, N-Q.1, N-Q.2, N-Q.3, RI. 9-10 1, 2, 3, 7, 8, 9, 10 or RI.11-12.1, 2, 3, 7, 8, 9, 10, RST.9-10. 8, 9 or RST.11-12.8, 9, S-CP.5, S-ID.1, 9, S-MD.5, 6, 7, WHST.9-10.8, 9 or WHST.11-12.8, 9, S-IC.5, 6 **7. 5.1.12.A1, 5.1.12.A2, 5.1.12.B1, 5.1.12.B2, 5.1.12.B4** **8. 5.1.12.A1,5.1.12.A2, 5.1.12.B4** **9. 5.1.12.A1,5.1.12.A2, 5.2.12.C1** **10. 5.1.12.A1, 5.1.12.A2** **11. 5.1.12.A1,5.1.12.A2, 5.1.12.B4, 5.1.12.D2,**

	2.2.12.B.1, 8.1.12.C.1, 9.1.12.A.1, 9.1.12.B, 9.4O, L.9-10.6 or L.11-12.6, N-Q.1, RI.9-10.2, 8 or RI.11-12.2, 8, RST.9-10.1, 9, 10 or RST.11-12.1, 9, 10, S-IC.6, S-ID.1, SL.9-10. 1 through 6 or SL.11-12.1 through 6, S-MD.5, 6, W.9-10.1, 7 or W.11-12.1, 7, WHST.9-10.1, 5, 7, 8, 9 or WHST.11-12. 1, 5, 7, 8, 9 **12. 5.1.12.A1,5.1.12.A2, 5.1.12.B4, 5.1.12.D2** **13. 5.1.12.A1, 5.1.12.A2, 5.1.12.B4, 5.1.12.D2**

Interdisciplinary 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 explore material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and/or 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.

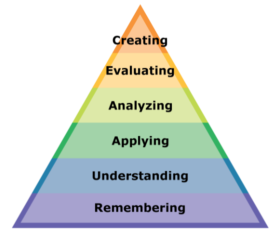
Students will work with/investigate concepts through laboratory investigation including:

- Gases and Temperature Lab (Simulation)
- Specific Heats of Coolants Lab
- Gas Laws Lab (Simulation)
- Mechanical Equivalent of Heat Lab
- Expansion Using Google Maps Lab
- Thermal Radiation Lab
- Thermal Conductivity Lab

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

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:

- "Learning Catalytics" software from Pearson Publishing responders for real-time analysis student understanding {R, U, Ap, An, E}
- Use of Socrative Clicker app and website for warm-up questions and exit tickets for real-time responses {R, U, Ap, An, E}
- 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 {R, U, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {R, U, Ap, An, S}
- Completion of independent practice worksheets and problem sets {R, U, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps {R, U, 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. {R,U, 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:

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Enrichment/Enhancement:

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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. Homework will be monitored using MasteringPhysics diagnostic tools (online)

Example assessments that are suggested by AP Central include:

- Gas Laws: To verify the relationships between pressure, temperature, and volume of a gas (air).
- Thermal Conductivity: To determine the thermal conductivity of a material by comparing the difference in temperature across one material to the difference in temperature across a second material of known thermal conductivity.
- Heat Engine: To determine how the work done by an engine that raises mass during each of its cycles is related to the area enclosed by its PVgraph.
- Efficiency of a Hair Dryer: To determine the efficiency of a hair dryer as it dries a wet towel.

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:

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Black Horse Pike Regional School District Curriculum

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

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

<table>
<tr>
<td>Course/Unit Title:
AP Physics II Electrostatics

Grade Level:
11/12</td>
<td>Unit Summary:
This unit will examine electric charge from two perspectives: electrostatics and electric potential. Students will use an inquiry-based approach to determine relationships (graphical and mathematical) between physical factors pertaining to electric forces, electric fields, electric potential and capacitance.

In the first part of the unit, students will investigate types of charge, the law of conservation of charge, methods of charging, and the forces and fields associated with charges or groupings of of charges. Electric charge comes in two forms (positive and negative) and is a conservable quantity. That is to say that charge is neither created nor destroyed but rather, transferred between objects. The three methods for transferring charge are contact, induction, and friction. When an object has a net charge it is due to an imbalance of positive and negative charges. When a net charge has accumulated on an object it will create an electric field that can influence other objects. This influence can be attractive (two opposite charges) or repulsive (two like charges). The force that is felt between two charges is described by inverse square law in which sizes of the charges and distance between their centers will be used to determine the size of the force felt between the objects.

In the second part of the unit, the concept of energy will be applied to charges. The energy per amount of charge is known as electric potential and when a charged is placed in a location that has an electric potential, it will acquire a potential energy (which can be converted into other various forms of energy).</td>
</tr>
<tr>
<td>Essential Questions:
What happens at the atomic level when an object is charged or polarized?</td>
<td>Enduring Understandings:
1. Electric charge is a fundamental property of matter and comes in two types: positive (protons) and negative (electrons)

2. Objects are electrically charged because of an imbalance of positive and negative charges. Neutral objects contain an equal amount of positive and negative charges</td>
</tr>
</table>

What is an electric field, and how can it be used to calculate force? What is an electric potential, and how is it related to potential energy? How can we visualize the electric field and electric potential produced by a charge configuration?	3. Two like charges will repel and two opposite charges will attract. The size of the force is proportional to the sizes of the charges and inverse squared to the distances between the charges and can be calculated using Coulomb's law 4. Electric charge is a conserved quantity in that it can only be transferred from one object to another 5. Conducting materials allow charge to pass through while insulators do not 6. Objects can acquire a charge one of three ways: friction, contact with another charged object, or induction 7. Electric force is a field force and does not require contact 8. Electric field lines point away from positive charges and point toward negative charges 9. Electric charge distributes itself on the surface of all conductors in a way that the net electric field inside is zero 10. Electric potential is a measure of the electric potential energy per unit of charge 11. Electric force and field are vector quantities and electric potential and electric potential energy are scalar quantities 12. A capacitor is a device that can store electric charge. The amount of charge that can be stored depends on several factors 13. The electric field inside of a capacitor is constant (excluding edge behavior)

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

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

<u>Learning Target</u>	<u>NJCCCS or CCS</u>
Note: all targets are restatements of learning objectives as provided by AP Central. While these targets must be addressed, teachers can feel free to add their own specific targets for each unit. 1. State the two fundamental types of electric charge 2. Identify the smallest unit of electric charge 3. State and apply the law of conservation of electric charge 4. Predict the size and direction of a net force on a pair of electric charges 5. List and explain the three methods (contact, induction and friction) in which an object can acquire a net electric charge 6. Determine the net charge on an object after a charging process has occurred 7. Use Coulomb's law to make predictions about the interaction between two electric point charges 8. Compare and contrast gravitational force and electric forces 9. Calculate the net electric force acting on a charged object from multiple charges 10. Describe contact forces between objects in terms of microscopic cause of those forces 11. Identify the distribution of excess charges in conducting and insulating materials 12. Explain electrical phenomena in terms charge separation, distribution, and forces	**1. 5.1.12.A1,** 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.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, **5.1.12.A2,** 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.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 **2. 5.1.12.A1, 5.1.12.A2** **3. 5.1.12.A1, 5.1.12.A2** **4. 5.1.12.A1, 5.1.12.A2** **5. 5.1.12.A1, 5.1.12.A2** **6. 5.1.12.A1, 5.1.12.A2** **7. 5.1.12.A1, 5.1.12.A2** **8. 5.1.12.A1, 5.1.12.A2** **9. 5.1.12.A1, 5.1.12.A2** **10. 5.1.12.A1, 5.1.12.A2** **11. 5.1.12.A1, 5.1.12.A2**

13. Predict the direction and magnitude of the force exerted on a charge placed in an electric field 14. Draw electric field lines associated with a given electric charge 15. Explain the inverse square dependence of the electric field surrounding an electrically charged object 16. Calculate the net magnitude and direction of the electric field arising from a group of more than two electric charges 17. Determine the size and direction of the net electric field inside the plates of a capacitor (including edge effects) 18. Describe the motion of a charged particle moving between two plates of a capacitor 19. Plot equipotential lines from given electric field lines 20. Calculate the electric potential difference between two locations in a uniform electric field	**12. 5.1.12.A1, 5.1.12.A2** **13. 5.1.12.A1, 5.1.12.A2** **14. 5.1.12.A1, 5.1.12.D2,** 2.2.12.B.1, 8.1.12.C.1, 9.1.12.A.1, 9.1.12.B, 9.4O, L.9-10.6 or L.11-12.6, N-Q.1, RI.9-10.2, 8 or RI.11-12.2, 8, RST.9-10.1, 9, 10 or RST.11-12.1, 9, 10, S-IC.6, S-ID.1, SL.9-10. 1 through 6 or SL.11-12.1 through 6, S-MD.5, 6, W.9-10.1, 7 or W.11-12.1, 7, WHST.9-10.1, 5, 7, 8, 9 or WHST.11-12. 1, 5, 7, 8, 9 **15. 5.1.12.A1, 5.1.12.A2** **16. 5.1.12.A1, 5.1.12.A2** **17. 5.1.12.A1, 5.1.12.A2** **18. 5.1.12.A1, 5.1.12.A2** **19. 5.1.12.A1, 5.1.12.A2, 5.1.12.D2** **20. 5.1.12.A1, 5.1.12.A2**

Interdisciplinary 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.

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How will students uncover content and build skills.

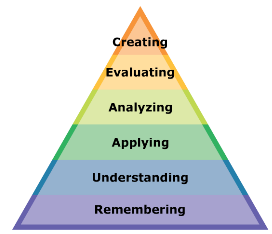
Students will explore material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and/or LoggerPro software. These technologies can be used as a class investigation prior to developing equations so that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

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

- "Electrostatic Magic" Activity
- Van de Graaff Generator Demonstrations Activity
- Plotting Equipotential Lines Activity
- "Electric Field Hockey" Activity
- Capacitor Simulation Lab
- Capacitance Lab (Real)

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

PART IV: EVIDENCE OF LEARNING



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<u>Formative Assessments</u>:

- "Learning Catalytics" software from Pearson Publishing responders for real-time analysis student understanding {R, U, Ap, An, E}
- Use of Socrative Clicker app and website for warm-up questions and exit tickets for real-time responses {R, U, Ap, An, E}
- 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 {R, U, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {R, U, Ap, An, S}
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- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps {R, U, Ap, An, S, E}
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<u>Accommodations/Modifications</u>:

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)

<u>Enrichment/Enhancement:</u>

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}

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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. Homework will be monitored using MasteringPhysics diagnostic tools (online)

Example assessments that are suggested by AP Central include:

- Electrostatics Investigations: To investigate the behavior of electric charges, charging processes, and the distribution of charge on a conducting object.
- The Electroscope: To make qualitative observations of the behavior of an electroscope when it is charged by conduction and by induction.
- Coulomb's Law: To estimate the net charge on identical spherical pith balls by measuring the deflection (angle and separation) between two equally charged pith balls.
- Electric Field and Equipotentials: To map equipotential isolines around charged conducting electrodes painted with conductive ink and construction of isolines of electric fields.

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)

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Black Horse Pike Regional School District Curriculum

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

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: *AP Physics II* *Current Electricity* **Grade Level:** 11/12	**Unit Summary:** This unit will expand on the concepts of current electricity that were presented in AP Physics I and will explain how moving charges can be used to produce other forms of energy. Students will use an inquiry-based approach to determine relationships (graphical and mathematical) between physical factors pertaining to electric potential difference (voltage), resistance, and current and other factors affecting these variables. Students will also further analyze the operation of electric circuits
Essential Questions: What factors affect the resistance of a material? How do charge conservation and energy conservation apply to direct current circuits? What is common to elements in series and parallel circuits? How do capacitors affect current in a circuit immediately after a switch is closed, as well as under steady-state conditions?	**Enduring Understandings:** 1. Resistivity is an intensivity property of matter that is dependent on the nature of the material. Resistance is an extensive property of matter that is determined by resistivity, length, and cross-sectional area 2. The current passing through a conductor is inversely related to the resistance of the conductor and proportionally related to voltage 3. Electric power is the product of current and voltage 4. The operation of electrical circuits are governed by the laws of conservation of charge and energy (Kirchhoff's rules)

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
Note: all targets are restatements of learning objectives as provided by AP Central. While these targets must be addressed, teachers can feel free to add their own specific targets for each unit. 1. Devise a procedure to determine the resistivity of a given material 2. Predict properties of resistors and/or capacitors when placed in a simple circuit based on the the placement in the circuit 3. Predict the behavior of an electric circuit given the positions of sources, resistors, capacitors, and switches 4. Design a plan to verify the relationships between current, voltage, and capacitance in series and parallel circuits 5. Use a schematic to determine the current, voltage and power delivered to resistors in a circuit 6. Experimentally verify Kirchhoff's loop rule ($\Delta V = 0$) 7. Apply Kirchhoff's loop and junction rules (in terms of energy and charge) to determine current and potential difference in circuit elements 8. Apply Kirchhoff's rules to multiple loop circuits to determine current magnitude and direction 9. Calculate the internal resistance of a battery or circuit 10. Determine missing values, direction of electric current, charge of capacitors at steady state, and potential differences in an RC circuit	**1. 5.1.12.A1,** 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.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**,** **5.1.12.A2,** 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.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, **5.1.12.B1,** 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.9-10.1 through 10 or RST.11-12.1 through 10, WHST.9-10.1 through 10 or WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.1.12.B2,** 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.9-10.1 through 10 or RST.11-12.1 through 10,

	WHST.9-10.1 through 10 or WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.1.12.B4,** 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.9-10.1 through 10 or RST.11-12.1 through 10, WHST.9-10.1 through 10 or WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **2. 5.1.12.A1, 5.1.12.A2** **3. 5.1.12.A1, 5.1.12.A2** **4. 5.1.12.A1, 5.1.12.A2, 5.1.12.B1, 5.1.12.B2**, **5.1.12.B4** **5. 5.1.12.A1,5.1.12.A2, 5.1.12.D2,** 2.2.12.B.1, 8.1.12.C.1, 9.1.12.A.1, 9.1.12.B, 9.4O, L.9-10.6 or L.11-12.6, N-Q.1, RI.9-10.2, 8 or RI.11-12.2, 8, RST.9-10.1, 9, 10 or RST.11-12.1, 9, 10, S-IC.6, S-ID.1, SL.9-10. 1 through 6 or SL.11-12.1 through 6, S-MD.5, 6, W.9-10.1, 7 or W.11-12.1, 7, WHST.9-10.1, 5, 7, 8, 9 or WHST.11-12. 1, 5, 7, 8, 9

	6. 5.1.12.A1,5.1.12.A2, 5.1.12.B1,5.1.12.B2, 5.1.12.B4 **7. 5.1.12.A1, 5.1.12.A2** **8. 5.1.12.A1, 5.1.12.A2** **9. 5.1.12.A1, 5.1.12.A2** **10. 5.1.12.A1, 5.1.12.A2**

Interdisciplinary 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.

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

Students will explore material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and/or 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.

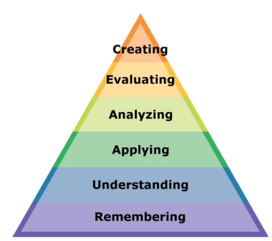
Students will work with/investigate concepts through laboratory investigation including:

- Resistance Lab
- Ohm's Law Lab (Simulations)
- Ohm's Law Lab (Real)
- Series and Parallel Circuits Simulation Lab
- Series and Parallel Circuits on a Breadboard Lab
- Verification of Equivalent Resistance Activity
- Verifying Multi-Loop Circuits Activity
- Temperature and Resistance Lab

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

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>:

- "Learning Catalytics" software from Pearson Publishing responders for real-time analysis student understanding {R, U, Ap, An, E}
- Use of Socrative Clicker app and website for warm-up questions and exit tickets for real-time responses {R, U, Ap, An, E}
- 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 {R, U, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {R, U, Ap, An, S}
- Completion of independent practice worksheets and problem sets {R, U, Ap, An, S}

- Unit wrap-up projects such as “Big Idea Posters”, YouTube Lessons, or Concept Maps {R, U, Ap, An, S, E}
- Laboratory investigations where students create situations which illustrate key concepts, and apply techniques from class to analyze the results. {R,U, 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}

Students will also be asked to keep an online portfolio of work that was completed in class. {R, U, 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

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. Homework will be monitored using MasteringPhysics diagnostic tools (online)

Example assessments that are suggested by AP Central include:

- Resistance and Resistivity: To explore the microscopic and macroscopic factors that influence the electrical resistance of conducting materials. Students will investigate how geometry affects the resistance of an ionic conductor using Play-Doh.
- DC Circuits- Brightness: To make predictions about the brightness of light bulbs in a variety of DC circuit configurations (series, parallel, and series-parallel) when some of the bulbs are removed.
- DC Circuits- Resistors: To investigate the behavior of resistors in series, parallel, and series-parallel DC circuits. The lab includes measurements of currents and potential differences.
- RC Circuits- Resistors and Capacitors: This investigation consists of two parts:
    - An observational experiment where the students make qualitative descriptions of the charging and discharging of a capacitor.
    - To investigate the behavior of resistors in a series-parallel combination with a capacitor in series. Their investigation includes measurement of currents and potential differences.

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

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: *AP Physics II Magnetism and Electromagnetism* **Grade Level:** 11/12	**Unit Summary:** This unit will introduce the concepts of magnetism and electromagnetism. Students will build upon knowledge of forces and conservation of energy to explain phenomena pertaining to fluids. Students will use an inquiry-based approach to determine relationships (graphical and mathematical) between physical factors pertaining to magnetic fields, magnetic forces and electromagnets. In the first part of the unit, students will examine the behavior of permanent magnets. This will include the forces that they exert on one another in varying orientations and the fields that they produce (including the field of the Earth). In this part of the unit students will also examine the magnetic behavior when charges or currents are involved. In the second part of the unit, students will examine how electric currents can be induced through the use of magnetic fields. Using the concept of magnetic flux, students will investigate how electric potentials can be created which can be used to create the electricity that is used in our homes.
Essential Questions: How can we describe a magnetic field due to single or multiple sources? How does a magnetic field interact with electric charge? How can we combine a magnetic field with an electric field to produce a beam of charged particles with a single velocity?	**Enduring Understandings:** 1. Opposite magnetic poles attract one another while like poles repel one another 2. All known magnets have a north and magnetic pole (magnetic monopoles have never been observed) 3. The Earth itself behaves as a bar magnet that shields us from dangerous cosmic radiation 4. A charged particle or current moving in a magnetic field will experience a force only if it has a component of its motion that is perpendicular to the magnetic field. The direction of the force can be predicted by using right-hand rule #1

How can changing magnetic flux produce an electric potential?	5. Ferromagnetic material becomes magnetized when the magnetic domains inside it are aligned 6. A current will produce a magnetic field that weakens as the distance from the current increases. The direction of the field can be determined by right-hand rule #2 7. Magnetic forces can be turned into torques, which can cause rotation (i.e. and electric motor) 8. Potential differences can be created by changing magnetic fields that pass through a coil of wire. This can be done several ways: rotating the coil in the field, varying the strength of the field, changing the area size of the coil, etc… 9. Electrical generators create potential differences by using other forms of energy to rotate coils or move magnets (hydroelectric, wind, fossil fuels…). These types of generators create alternating current (AC) 10. Transformers operate by using a secondary coil to pick-up the magnetic field that is created by a primary coil. Voltage is changed when the number of loops are different in the two coils 11. A coil can create self-inductance (back emf) that can happen when a circuit is opened or closed. This happens due to a rapidly changing current that can induce a new voltage 12. Power is transmitted long distances through voltage changes. Too much energy loss occurs if it was transmitted using current

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**
Note: all targets are restatements of learning objectives as provided by AP Central. While these targets must be addressed, teachers can feel free to add their own specific targets for each unit.	
1. Use magnetic domains to describe the magnetic behavior of a bar magnet composed of ferromagnetic material	**1. 5.1.12.A1,** 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.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, **5.1.12.A2,** 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.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
2. Describe how the magnetic properties of some materials can be affected by magnetic properties of other objects in the system	**2. 5.1.12.A1, 5.1.12.A2**
3. Map the magnetic field lines surrounding magnet and/or groups of magnets	**3. 5.1.12.A1, 5.1.12.A2**
4. Explain the behavior of a compass	**4. 5.1.12.A1, 5.1.12.A2**
5. Determine the force exerted on a moving charged object by a magnetic field	**5. 5.1.12.A1,5.1.12.A2**
6. Draw the magnetic field around a long straight wire or a pair of parallel wires	**6. 5.1.12.A1,5.1.12.A2**
7. Calculate the magnitude and direction of the magnetic field produced produced by a straight wire and a coil of wire	**7. 5.1.12.A1, 5.1.12.A2**
8. Define magnetic flux in terms of loop area, magnetic field strength, and orientation of the loop in the magnetic field	**8. 5.1.12.A1, 5.1.12.A2**
9. Explain how an emf is produced by a changing flux	**9. 5.1.12.A1, 5.1.12.A2**
10. Apply Faraday's and Lenz's laws to determine the magnitude and direction of an induced emf	**10. 5.1.12.A1, 5.1.12.A2**

Interdisciplinary 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 explore material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and/or 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.

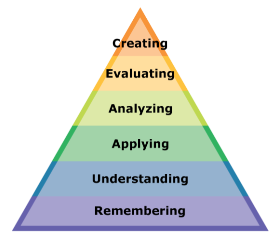
Students will work with/investigate concepts through laboratory investigation including:

- Using Vernier/Pasco probeware to measure and compare physical variables
- Video Analysis when applicable
- PhET simulations/Gizmos to discover relationships between more abstract variables
- Various demonstrations of phenomena using equipment from room inventory
- Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledges

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

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>:

- "Learning Catalytics" software from Pearson Publishing responders for real-time analysis student understanding {R, U, Ap, An, E}
- Use of Socrative Clicker app and website for warm-up questions and exit tickets for real-time responses {R, U, Ap, An, E}
- 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 {R, U, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {R, U, Ap, An, S}
- Completion of independent practice worksheets and problem sets {R, U, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps {R, U, 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. {R,U, Ap, An, S, E}

<u>Accommodations/Modifications</u>:

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)

<u>Enrichment/Enhancement:</u>

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:

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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. Homework will be monitored using MasteringPhysics diagnostic tools (online)

Example assessments that are suggested by AP Central include:

- Magnetic Field of the Earth: To measure the horizontal component of the Earth's magnetic field using a solenoid and a compass.
- Magnetic Force on a Current-Carrying Wire: To determine the magnitude and direction of the magnetic force exerted on a current-carrying wire.
- Electromagnetic Induction: The students move a bar magnet in and out of a solenoid and observe the deflection of the galvanometer. They examine the effects of a changing magnetic field by observing currents induced in a solenoid and determine whether the observations agree with the theory of electromagnetic induction and Lenz' Law.

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:

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Black Horse Pike Regional School District Curriculum

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

PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

<table>
<tr>
<td>Course/Unit Title:
Light and Optics

Grade Level:
11/12</td>
<td>Unit Summary:

This unit will introduce the concept of light as a wave and its behavior at boundaries. Students will build upon knowledge of forces and conservation of energy to explain phenomena pertaining to fluids. Students will use an inquiry-based approach to determine relationships (graphical and mathematical) between physical factors pertaining to reflection, refraction, diffraction, and lenses and mirrors.

The unit will begin with by examining light as a member of the electromagnetic spectrum. Students will then investigate the behavior of light when it encounters a boundary. When light strikes a surface, it will reflect. Specifically, students will look at light as it reflects off of plane and spherical mirrors.

When light encounters a transparent surface, it can either reflect or enter the new medium. If the new medium has a different index of refraction than the original medium, light will refract.

When light encounters an opening in a boundary, it will diffract through the opening. Specifically, students will examine the behavior of light as it passes through a double slit or diffraction grating.</td>
</tr>
<tr>
<td>Essential Questions:
How do mechanical waves and electromagnetic waves propagate?

What causes light to bend as it exits one medium and enters another?

How can we use the thin lens (or mirror) equation</td>
<td>Enduring Understandings:
1. An electromagnetic wave is produced by an oscillating electric charge and carries energy in the form of oscillating electric and magnetic fields

2. Visible light is just one small component of the electromagnetic spectrum

3. All electromagnetic waves travel at the speed of light ($c=3 \times 10^8$ m/s) in a vacuum. Waves will travel slower is more dense materials</td>
</tr>
</table>

to predict the size and location of an image? *How do the principal rays commonly used in ray diagrams obey the law of reflection for mirrors and the law of refraction for lenses?*	4. Frequency and wavelength of electromagnetic waves are inversely related 5. The angle of reflection of a light ray is equal to the angle of incidence when measured from a line that is normal to the surface in which it strikes 6. When light switches from one transparent medium to another, it will bend toward or away from the normal line, depending upon the indices of refraction of the two materials. If conditions are right, light will not be refracted and instead it will be internally reflected 7. The shape of a lens causes parallel rays to be redirected at different angles. This allows for images to be larger/smaller, real/virtual, and inverted/upright. Ray diagrams can be used to determine these images 8. Light waves bend as they pass by edges or through openings. This is known as diffraction 9. When two or more waves interact, their amplitudes superimpose and will produce constructive (bright) or destructive (dark) interference 10. When coherent light passes through two narrow slits and projected onto a screen, an interference pattern of repeating bright and dark fringes will be produced (with the central fringe being brightest and progressively getting fainter as distance from the center increases). This can only be explained if light has a wave-like nature 11. Thin-film interference is explained by phase shifts as light is reflected from different boundaries and path differences between refracted light rays. The combination of phase shifts and path differences results in constructive interference of some colors of light and destructive interference of others

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**
Note: all targets are restatements of learning objectives as provided by AP Central. While these targets must be addressed, teachers can feel free to add their own specific targets for each unit. 1. Explain the formation of electromagnetic waves in terms of changing electric and magnetic fields 2. Contrast mechanical and electromagnetic waves in terms of the need for a medium in wave propagation 3. Make qualitative comparisons of the wavelengths of types of electromagnetic radiation 4. Using a graphical representation, determine the equation of a wave function of horizontal position and time 5. Use single-slit diffraction to explain how light passes energy around the corner of a small opening 6. State and apply the law of reflection of light 7. Determine the size and location of an image produced by a plane mirror 8. Use ray diagrams to locate images formed by spherical mirrors 9. Apply the lens-maker and magnification equations to determine locations, heights and magnification of images in mirrors 10. Devise a plan and experimentally determine the focal length of a concave mirror 11. Explain why light refracts when it switches from one medium into another	**1. 5.1.12.A1,** 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.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, **5.1.12.A2,** 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.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 **2. 5.1.12.A1, 5.1.12.A2** **3. 5.1.12.A1, 5.1.12.A2** **4. 5.1.12.A1, 5.1.12.A2** **5. 5.1.12.A1, 5.1.12.A2** **6. 5.1.12.A1, 5.1.12.A2** **7. 5.1.12.A1, 5.1.12.A2** **8. 5.1.12.A1, 5.1.12.A2** **9. 5.1.12.A1, 5.1.12.A2** **10. 5.1.12.A1, 5.1.12.A2, 5.1.12.B1,** 2.2.12.B.1, 8.1.12.A, 8.1.12.C,

12. State and apply Snell's law (including for total internal reflection) 13. Experimentally verify Snell's law (refraction) 14. Use ray diagrams to locate images formed by lenses 15. Apply the lens-maker and magnification equations to determine locations, heights and magnification of images in lenses 16. Devise a plan and experimentally determine the focal length of a converging lens 17. Use the principle of superposition to explain Young's double slit experiment 18. Use the principle of superposition to explain thin-film interference	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.9-10.1 through 10 or RST.11-12.1 through 10, WHST.9-10.1 through 10 or WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.1.12.B2,** 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.9-10.1 through 10 or RST.11-12.1 through 10, WHST.9-10.1 through 10 or WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1, **5.1.12.B4,** 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.9-10.1 through 10 or RST.11-12.1 through 10, WHST.9-10.1 through 10 or WHST.11-12.1 through 10, N-R.1 through 3, N-Q.1 through 3, S-ID.1 **11. 5.1.12.A1, 5.1.12.A2** **12. 5.1.12.A1, 5.1.12.A2** **13. 5.1.12.A1, 5.1.12.A2, 5.1.12.B1, 5.1.12.B2, 5.1.12.B4** **14. 5.1.12.A1, 5.1.12.A2**

	15. 5.1.12.A1, 5.1.12.A2 **16. 5.1.12.A1, 5.1.12.A2, 5.1.12.B1, 5.1.12.B2, 5.1.12.B4** **17. 5.1.12.A1, 5.1.12.A2** **18. 5.1.12.A1**

Interdisciplinary 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 explore material through multi-media presentations utilizing PowerPoint, YouTube videos, video clips, PhET simulations, Gizmos, LabPro and Pasco data collection devices, and/or 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

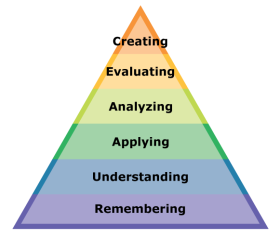
Labs will be used to relate the mathematical concepts to the real world

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

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>:

- "Learning Catalytics" software from Pearson Publishing responders for real-time analysis student understanding {R, U, Ap, An, E}
- Use of Socrative Clicker app and website for warm-up questions and exit tickets for real-time responses {R, U, Ap, An, E}
- 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 {R, U, Ap, An}
- Weekly quizzes that evaluate student ability to analyze student understanding both conceptual questions and mathematical problems {R, U, Ap, An, S}
- Completion of independent practice worksheets and problem sets {R, U, Ap, An, S}
- Unit wrap-up projects such as "Big Idea Posters", YouTube Lessons, or Concept Maps {R, U, 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. {R,U, Ap, An, S, E}

<u>Accommodations/Modifications</u>:

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)

<u>Enrichment/Enhancement:</u>

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

<u>Summative Assessments</u>:

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}

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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. Homework will be monitored using MasteringPhysics diagnostic tools (online)

Example assessments that are suggested by AP Central include:

- Reflection: Students design an investigation to answer the following question: "Are there any patterns in the way plane mirrors and curved mirrors reflect light?"
- Concave Mirrors: This investigation has two parts:
    - To determine the focal length of a concave mirror.
    - To determine two locations where a magnified image can be formed using a concave mirror.
- Index of Refraction: To determine the index of refraction of an acrylic block.
- Lenses: This investigation is divided into two parts:
    - To directly determine the focal length of a converging lens directly.
    - To determine the focal length of a diverging lens by combining it with a converging lens.
- Double-Slit Interference and Diffraction: This lab activity consists of three parts where the students design each investigation:
    - To determine the wavelength of a green laser using a double slit.
    - The students apply the results of the previous experiment to predict the location of bright and dark fringes when a red laser of known wavelength is used.
    - The students determine the spacing in a diffraction grating using either the green or the red laser.

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PART I: UNIT RATIONALE

WHY ARE STUDENTS LEARNING THIS CONTENT AND THESE SKILLS?

Course/Unit Title: *Atomic/Nuclear and Modern Physics* **Grade Level:** 11/12	**Unit Summary:** This unit will introduce concepts in modern physics. These topics will include the dual nature of light and matter as well as nuclear structure and reactions within the nucleus. Students will build upon knowledge of forces and conservation of energy to explain phenomena pertaining to atomic nuclei. Students will use an inquiry-based approach to determine relationships (graphical and mathematical) between physical factors pertaining to light energy and interaction between light and subatomic particles
Essential Questions: How is the photoelectric effect simply a restatement of the law of conservation of energy? Under what conditions does a particle act like a wave or a wave act like a particle? What quantities are conserved in a nuclear reaction?	**Enduring Understandings:** 1. The energy of a photon of light is directly proportional to its frequency 2. The photoelectric effect is a restatement of the law of conservation of energy in terms of light and freed electron motion 3. Experimental evidence shows that light exhibits both wave and particle properties. This is known as wave-particle duality 4. Experimental evidence shows that light causes changes to occur in the subatomic realm of electrons and protons and that these interactions are governed by the conservation of energy. 5. Atomic nuclei form predictable stable configurations and when these configurations are altered as in the case of isotopes, nuclei will decay to form new atoms. 6. Atomic decay takes place in predictable reactions and these reactions can be used to predict the products of nuclear decay.

	7. The speed of light in a vacuum is an absolute speed limit 8. Space and time are interrelated in a continuum known as space-time 9. The measurement of time is relative to the observer's frame of reference. Time for you is different than time for me if we are moving relative to one another 10. Time slows down for moving observers relative to the time measured by stationary observers. This time dilation can be calculated using a Lorentz transform 11. The length of an object decreases in the direction of travel as an object approaches the speed of light. This length contraction can be calculated using a Lorentz transform

PART II: INSTRUCTIONAL STRATEGIES AND RESOURCES

DESCRIBE THE LEARNING TARGETS.

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

<u>**Learning Target**</u>	<u>**NJCCCS or CCS**</u>
Note: all targets are restatements of learning objectives as provided by AP Central. While these targets must be addressed, teachers can feel free to add their own specific targets for each unit. 1. Use quantum energy levels of an electron in an atom to explain emission and absorption spectra 2. Use the photoelectric effect as evidence to support the photon model of radiant energy 3. Select the appropriate model (particle or wave) for solving problems of varying scales 4. Use the de Broglie wavelength to determine the momentum of a photon 5. Use the wave model of matter as appropriate to explain the diffraction of matter interacting with a crystal	**1. 5.1.12.A1,** 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.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, **5.1.12.A2,** 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.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 **2. 5.1.12.A1, 5.1.12.A2**

6. Use integer multiples of the de Broglie wavelength to account for the existence of specific allowed energy states of an electron in an atom 7. Use half-life to predict the number of radioactive nuclei remaining in a sample after a certain period of time 8. Predict the missing species (alpha, beta, or gamma) in a radioactive decay 9. Construct or interpret representations of transitions between atomic energy states involving the emission and absorption of photons 10. Determine the frequency and wavelength of photons emitted when electrons transition between energy levels 11. Explain the role of the strong nuclear force in holding a nucleus together 12. Solve for the mass-energy equivalence of matter 13. Use the conservation laws of nucleon number and charge to determine the daughter nuclei in decay reactions 14. Explain why alternative modern models must be used to explain physical phenomena 15. Cite examples of why classical mechanics must be replaced by special relativity to describe the experimental results and theoretical predictions that show that the properties of space and time are not absolute 16. Provide reasons for why the theory of conservation of mass was replaced by the theory of conservation of mass-energy 17. Explain the concept of time dilation and length contraction as it applies to objects travelling close to the speed of light 18. Explain how an object gains mass as it speeds up and how this mass gain is an absolute barrier to travelling faster than the speed of light	**3. 5.1.12.A1, 5.1.12.A2** **4. 5.1.12.A1, 5.1.12.A2** **5. 5.1.12.A1, 5.1.12.A2** **6. 5.1.12.A1, 5.1.12.A2** **7. 5.1.12.A1, 5.1.12.A2, 5.2.12.A4,** 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.9-10 or RST.11-12, WHST.9-10 or WHST.11-12 **8. 5.1.12.A1, 5.1.12.A2, 5.2.12.A4** **9. 5.1.12.A1, 5.1.12.A2** **10. 5.1.12.A1, 5.1.12.A2** **11. 5.1.12.A1, 5.1.12.A2** **12. 5.1.12.A1,5.1.12.A2** **13. 5.1.12.A1, 5.1.12.A2, 5.2.12.A4, 5.2.12.D3,** 6.1.12.C.12, 6.1.12.C16, 6.2.12.C.5, 7.1.IL.A.7, 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; **14. 5.1.12.A1, 5.1.12.A2** **15. 5.1.12.A1, 5.1.12.A2** **16. 5.1.12.A1, 5.1.12.A2**

19. Use Lorentz tranforms to determine the time dilation and length contraction for an object travelling close to the speed of light	**17. 5.1.12.A1, 5.1.12.A2** **18. 5.1.12.A1, 5.1.12.A2** **19. 5.1.12.A1, 5.1.12.A2**

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

- Using Vernier/Pasco probeware to measure and compare physical variables
- Video Analysis when applicable
- PhET simulations/Gizmos to discover relationships between more abstract variables
- Various demonstrations of phenomena using equipment from room inventory
- Use of POGIL discussions/worksheets to introduce topics in which students have no familiarity to guide them to construct new knowledges

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

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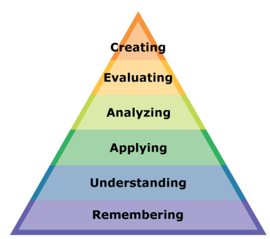

Formative Assessments:

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Example assessments that are suggested by AP Central include:

- Spectroscopy: Students use a quantitative analysis spectroscope to analyze flame tests and spectrum tubes.
- Photoelectric Effect: Students determine Planck's constant from data collected from a circuit with an LED color strip
- Radioactive Decay and Half-Life: In this investigation, students simulate radioactive decay and determine half-life.

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