Escondido Union High School District

Agricultural Physics

EUHSD Board Approval Date: 3/9/2021
The EUHSD Agricultural Physics curriculum document identifies what students should be able to know by grade level in a comprehensive standards-based course of study. The curriculum document is updated annually based on student academic achievement data, research and best practices, and input from stakeholders. The EUHSD curriculum document contains the following documents and/or information:

A. Course Description
B. Course Guidelines/Requirements - graduation credit information, transcript information, adopted materials, adopted technology, assessment outline
C. Instructional Materials References
D. Scope and Sequence Map with Essential Standards outlined by Unit
E. References to key essential design and implementation documents

The EUHSD Agriculture program is designed to meet both the California Content Standards for specific disciplines and to address key California Career Technical Education standards for specific industry sector pathways. The Agricultural Physics course was designed as a key course within the Agriculture and Natural Resources pathway, but also serves as a foundational “D” laboratory science course in the agriculture program. The curriculum document was written to address both pathway and overarching anchor standards as well as key Next Generation Science Standards.

**Escondido Union High School District – Mission**
Empowering every student to graduate prepared for college, career, and life through excellence in learning.

**Escondido Union High School District – Vision**
We relentlessly pursue, with optimism, equitable support for all students to navigate a changing world by providing rigorous and relevant learning experiences that strengthen their capacity as
- Open-minded and invested collaborators;
- Effective and thoughtful communicators;
- Resourceful and creative problem solvers;
- Curious and analytical critical thinkers;
- Informed and compassionate community members.

**Curriculum Design Resources**
The curriculum document is aligned to the California Next Generation Science Standards and serves to support outcomes evidenced in the College and Career Readiness Standards for students in grades 9-12. A detailed list of resources around which the EUHSD curriculum is designed is as follows:

7. https://ucci.ucop.edu/ - UCCI Model of Instruction
8. https://www.cteonline.org - CTE Online
Agricultural Physics Course Description

This is an Agricultural Physics course intended for those students whose interest is in agriculture. It gives students a good foundation in Physics with related Earth Science phenomena and Agricultural applications. The following topics are covered: forces, laws of motion, structures, momentum, collisions, energy, waves, electricity and magnetism. Additionally, students will connect the products created in this class with industry activities to link real world encounters and implement skills demanded by both colleges and careers. The course culminates with an agriscience experimental research project in which students design and conduct an experiment to solve a relevant issue. Final projects will be eligible for the Career Development Event competition at FFA events. Throughout the course, students will be graded on participation in intra-curricular FFA activities as well as the development and maintenance of an ongoing Supervised Agricultural Experience (SAE) Program. A variety of opportunities are offered to students during class time, after school and on weekends to help student fulfill the required hours needed to meet FFA requirements.

Agricultural Physics Course Requirements

<table>
<thead>
<tr>
<th>Course Length:</th>
<th>Year Long</th>
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<tbody>
<tr>
<td>UC/CSU Requirement:</td>
<td>Meets UC/CSU “D” lab science (physical science) requirements</td>
</tr>
<tr>
<td>Course Numbers (Semester A):</td>
<td>5750</td>
</tr>
<tr>
<td>Course Numbers (Semester B):</td>
<td>5751</td>
</tr>
<tr>
<td>Credits (Semester A):</td>
<td>5 Physical Science</td>
</tr>
<tr>
<td>Credits (Semester B):</td>
<td>5 Physical Science</td>
</tr>
<tr>
<td>Required Prerequisite/s:</td>
<td>Completion or concurrent enrollment in Math 1 (Integrated) or Algebra 1</td>
</tr>
<tr>
<td>Board Approval Date (Curriculum):</td>
<td>3/9/21</td>
</tr>
<tr>
<td>Board Approval Date (Materials):</td>
<td>3/9/21</td>
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**Core Instructional Material/s:**
- Free Physics Resource website - [http://www.physicsclassroom.com](http://www.physicsclassroom.com)
- University of Colorado Gravity Lab Simulation - [https://phet.colorado.edu/en/simulation/gravity](https://phet.colorado.edu/en/simulation/gravity)
- RFID website - [http://www.rfidjournal.com/site/about](http://www.rfidjournal.com/site/about)

**Supplemental Instructional Material/s:**
- [http://www.physicsclassroom.com](http://www.physicsclassroom.com)
- [https://phet.colorado.edu/en/simulation/gravity](https://phet.colorado.edu/en/simulation/gravity)
- [https://www.khanacademy.org/science/physics](https://www.khanacademy.org/science/physics)
- [http://www.rfidjournal.com/site/about](http://www.rfidjournal.com/site/about)

**Transcript Abbreviation (Semester A):** AGRICULTURAL PHYSICS A (P)

**Transcript Abbreviation (Semester B):** AGRICULTURAL PHYSICS B (P)

**Graduation Requirement:** Meets EUHSD Physical Science Requirement or CTE Requirement or Elective Credit

**Recommended Prerequisite/s:** Biology and Sustainable Agriculture & Chemistry & Agriscience

**Credits (Semester A):** 5 Physical Science

**Credits (Semester B):** 5 Physical Science

**Grade Level:** 10-12

**Board Approval Date (Curriculum):** 3/9/21

**Board Approval Date (Materials):** 3/9/21
<table>
<thead>
<tr>
<th>Technology Resource/s:</th>
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<tbody>
<tr>
<td>• Class set of chrome books and/or access to a computer lab when applicable (see specific units of study)</td>
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<tr>
<td>• Probeware</td>
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<table>
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<tr>
<th>Assessment/s:</th>
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<tr>
<td>• Completion of required unit assessments as outlined in the Scope and Sequence Guide</td>
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<table>
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<tr>
<th>Meeting the Needs of ELs:</th>
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<tbody>
<tr>
<td>• Utilize the student information system to acquire the language levels of EUHSD English Learners.</td>
</tr>
<tr>
<td>• In 2012, the CA Department of Education adopted new language level proficiency descriptors and new EL state standards. Visit the following website to learn more about those new descriptors and corresponding standards: <a href="http://www.cde.ca.gov/sp/er/educators/eldstdspub/publication14.pdf">http://www.cde.ca.gov/sp/er/educators/eldstdspub/publication14.pdf</a></td>
</tr>
<tr>
<td>• In 2014, the CA Department of Education adopted new ELA-ELD Framework, with specific strategies designed to meet the needs of EL students. Visit the following URL to learn more about the new frameworks: <a href="http://www.cde.ca.gov/ci/rl/cf/documents/elaeldfwchapter11.pdf">http://www.cde.ca.gov/ci/rl/cf/documents/elaeldfwchapter11.pdf</a></td>
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**Agricultural Physics Scope and Sequence Guide**

The Scope and Sequence Guide is a California standards-based document that delineates the standards-based skills students are expected to know and do in order to meet College and Career Readiness expectations outlined within the California Next Generation Science Standards. Each unit of study in the Scope and Sequence document is designed to build upon the previous unit and/or prerequisite coursework in support of student mastery of specific standards-based skills. The Scope and Sequence document provides the framework of understanding for key assignments, key assessments, and instructional resources and strategies that serve to assist students in meeting unit learning objectives. EUHSD teachers will meet annually to review and refine the curriculum. The Scope and Sequence document provides references to timeframes for unit implementation.
## Unit Description:
Unit 1 provides students with an introduction to physics and to the lab workspace and safety features of the classroom lab experience. Topics including dimensional analysis, lab safety, and unit conversions will be covered.

### Transfer Goals:
- **CTE**
  - Demonstrate knowledge of safety rules and practices to prevent harm.
  - Work effectively in teams by committing to producing a quality product, taking responsibility for individual roles and timelines, and examining the overall result.
- **Science**
  - Plan and conduct investigations that contribute evidence to explanatory models or support proposals to solutions.
- **ELA**
  - Use appropriate and purposeful communication strategies in authentic situations to build community while being sensitive to culture and context.
- **Technology**
  - Leverage the appropriate digital tools to have the intended impact on your audience.

### Understandings:
- Laboratory tools produce data that can be used as evidence to answer research questions.
- The collection of measurements have standards with accuracy and reliability so that scientists can compare results from investigations.

### Essential Questions:
- How has the field of agriculture benefited from a greater understanding of the universe through the field of physics?
- Why are measurement practices essential for agricultural practices?

### Unit Standards:

#### Agriculture & Natural Resources:
- 6.1 Locate, and adhere to, Material Safety Data Sheet (MSDS) instructions.
- 6.2 Interpret policies, procedures, and regulations for the workplace environment, including employer and employee responsibilities. 3 ANR | California Career Technical Education Model Curriculum Standards.
- 6.3 Use health and safety practices for storing, cleaning, and maintaining tools, equipment, and supplies.
- 6.4 Practice personal safety when lifting, bending, or moving equipment and supplies.

### Learning Objectives:

#### Knowledge and Skills:
- Describe and demonstrate lab safety protocols.
- Quantitatively convert within a system of measurement.
- Use dimensional analysis to convert between different units of measurement.
- Demonstrate proper use of measurement tools.
- Properly use terminology associated with experimentation (variables, hypothesis, purpose, and data).

### Performance Tasks:
- **Physics and Agriculture**: Why do plants grow up? What causes the seasons? How do satellites communicate with agricultural equipment to be autonomous? These and many other questions are selected by teams of students to identify the relevant physics phenomena and explain how physics has enabled those in the agricultural field to be more successful. Students present these reports to the class using digital tools to have the necessary impact on the audience.
- **How tall is my tree?** Students are tasked with measuring trees across campus using methods of their own design. Students use these measurements to determine which tree has the greatest height and volume and how they know. This task drives the
<table>
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<tr>
<th>6.5 Demonstrate how to prevent and respond to work-related accidents or injuries; this includes demonstrating an understanding of ergonomics.</th>
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<tbody>
<tr>
<td>6.6 Maintain a safe and healthful working environment.</td>
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<tr>
<td>6.7 Be informed of laws/acts pertaining to the Occupational Safety and Health Administration (OSHA).</td>
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<tr>
<td>Demonstrate appropriate work habits both independently and when working with others.</td>
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<td>introduction to standardized measurement practices in the field of agriculture and how they support quality products.</td>
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<tr>
<td><strong>Laboratory Safety</strong>: Students take the laboratory safety module and pass a safety demonstration in the field.</td>
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Agricultural Physics Scope and Sequence
Unit 2 – Kinematics and Forces
Length: 6 weeks

Unit Description: Students begin with a careful study of motion, the foundation of all physics. They will understand that motion can be represented by a position-time graph and that all objects free fall move with the same constant acceleration. They will also learn how the horizontal and vertical motions of an object are independent of one another. Students will solve problems involving displacement, velocity, and acceleration. Students will begin with studying rates as they apply to farming practices including animal feeding rates, crop and general irrigation rates, and vehicle speeds. Students will use various agricultural tools to measure rates. They will document the rates in their science journal, including the use of sketches and formulas. For example, they will look at speed and velocity of animals. They will discuss the differences between speed and velocity. They will solve problems and verify their answers.

Transfer Goals:
- CTE
  - Understand a problem and work to solve it by asking questions, researching information, and testing out ideas until resolved.
  - Evaluate how business choices impact economic, cultural, and environmental factors to guide decision-making.
- Science
  - Use mathematical and computational thinking to analyze data to support explanations of phenomena or design solutions to problems.
  - Construct and revise explanations about relevant phenomena supported by multiple sources of evidence.
  - Engage in productive argumentation using evidence to explain phenomena, challenge ideas, and propose solutions to problems.
- ELA
  - Write routinely for a variety of tasks, purposes, and audiences to develop skills, build stamina, and grow confidence in writing.
  - Develop a claim and support it with evidence from the content that can be used to make connections, draw conclusions, and/or advocate for change.
- Technology
  - Use both critical thinking and technology skills to validate information, challenge assumptions, and responsibly share content.

Understandings:
- The motion of objects must be defined by using a frame of reference.
- There are two main types of one-dimensional motion: motion with constant velocity (at rest is a particular case of this) and accelerated motion (changing velocity).
- Motion can be analyzed graphically.

Essential Questions:
- How do forces cause and affect motion?
- How do the principles of physics explain natural phenomenon?
- How is it possible for an object to stay in constant motion or constant rest forever?
- If you are travelling in a car, are you at rest or are you moving?
- How can motion be quantified and communicated scientifically?
Unit Standards:

NGSS Performance Expectations:
- HS-PS2-1: Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
- HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including costs, safety, reliability and aesthetics, as well as possible social, cultural and environmental impacts.

Agricultural and Natural Resources Pathway Standards:
- C13.0 Design agricultural experiments using the scientific method.
- C13.1 State the steps of the scientific method.
- C13.2 Analyze an agricultural problem and devise a solution based on the scientific method.
- C2.3 Summarize how natural resources are used in agriculture.
- C2.4 Compare and contrast practices for conserving renewable and nonrenewable resources.
- C2.5 Research how new energy sources are developed from agricultural products (e.g., gas cogeneration and ethanol).

Learning Objectives:

Knowledge and Skills:
- Use appropriate academic content language in written evaluation and discussions.
- Plan and carry out investigations involving forces and kinematics.
- Develop and use graphical models to explain or predict data.
- Use mathematics and computational thinking to quantify variables (velocity, acceleration, displacement, force, and mass).
- Obtain, evaluate and communicate information based on Newton’s three laws.
- Identify and explain scalars and vectors.
- Qualitatively predict the effect of angle on displacement.
- Apply Newton’s 3 laws to various scenarios.
- Draw and label free body diagrams to predict motion of objects.

Performance Tasks:
- Constant Velocity Tractor: In this constant velocity lab students will plan and carry out an investigation to determine the relationship between position and time of constant velocity autonomous tractors on a farm. Students will analyze and interpret the data to develop and use graphical models that will identify the pattern between position and time. Students will present their findings on a chart to share out with the class. They will then discuss how to monitor the path of autonomous vehicles on the farm.
- Salad Dressing Acceleration Investigation: In this acceleration lab students will plan and carry out an investigation to determine the relationship between velocity and time for salad dressing that allows food manufacturers to measure the viscosity of their mixture. Students will analyze and interpret the data to develop and use graphical models that will identify the pattern between position and time. Students will use mathematical and computational thinking to determine that acceleration of the car. At the conclusion of their lab, students will then be given various graphs in which they can qualitatively and quantitatively construct explanations for the motion of manufactured food products and other agricultural applications. These can include animal feeding rates, crop and irrigation rates, and other applications of objects in motion.
- Biomimicry and Newton’s Second Law: In this lab students will plan and carry out an investigation using spring scales (or force probes) to determine the relationship between acceleration, mass of the object and net force acting on an object. This will allow students to study the motion of insects on the farm and how their motion and forces on crops allow for the pollination of plants. Students will design an artificial pollinator and present their findings based on research on Newton’s second law.
### Unit Description:
Students will investigate Newton's Universal Law of Gravitation, Kepler's Laws, and circular motion. Newton's laws of motion and kinematic principles are applied to describe and explain the motion of objects moving in circles. Emphasis will be on identifying and explaining what creates and effects the force of gravity between objects, explaining the motion of orbiting objects and solving for net force on an object experiencing circular motion. Students will use explanatory models of circular motion to explain how satellites support observations of climate and weather that impact crops across our planet. Additionally, they explore how satellites enable us to use GPS and other communication technologies that support the field of agriculture.

### Transfer Goals:
- **CTE**
  - Communicate effectively based on who they are talking to, what message they need to share, and what method (e.g., phone call, email, written report) using industry-standard vocabulary.
  - Explore various career options and prepare to compete in a marketplace through ongoing training, experience, and certification.
- **Science**
  - Develop, use, and refine models that represent ideas and communicate relationships to make predictions towards understanding phenomena.
  - Obtain and evaluate relevant, valid, and reliable sources of information in order to effectively communicate through various methods.
- **ELA**
  - Engage in a purposeful process of revision and reflection to structure and develop polished content that effectively conveys an intended message.
- **Technology**
  - Use technology to explore, develop, and pursue their own strengths and interests.

### Understandings:
- Centripetally directed forces govern many phenomena.
- The acceleration of an object depends upon its mass and the net force acting on it.

### Essential Questions:
- How can you explain phenomenon that involves centripetal force?
- What can cause objects to not maintain a circular path?

### Unit Standards:

<table>
<thead>
<tr>
<th>NGSS Performance Expectations</th>
<th>Learning Objectives</th>
<th>Performance Tasks</th>
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<tbody>
<tr>
<td><strong>HS-ESS-1-4</strong>: Use mathematical or computational representation to predict the motion of orbiting objects in the solar system.</td>
<td><strong>Knowledge and Skills</strong>:</td>
<td><strong>Plant Gravitropism</strong>: Students will plan and conduct an investigation into how plants know which direction to grow. They will construct an explanatory model of gravitropism and use their evidence of gravity force to propose how to plant in outer space. Students will use free body diagrams to explain the forces at play for launching a satellite into space and then growing crops.</td>
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<tr>
<td><strong>HS-PS2-1</strong>: Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass and its acceleration.</td>
<td><strong>Performance Tasks</strong>:</td>
<td></td>
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### Length: 6 weeks
• HS-PS2-4: Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.
• HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Agricultural and Natural Resources Pathway Standards:
• C2.0 Examine the interrelationship between agriculture and the environment.
• C2.1 Identify important agricultural environmental impacts on soil, water, and air.
• C2.2 Explain current environmental challenges related to agriculture.

• Relate gravitational force to mass and distance.
• Identify Kepler’s three laws and state their importance to orbits.
• Draw force diagrams of objects experiencing circular motion and determine net force.

• Farmers’ Almanac and Satellite Motion: In this activity students will observe satellite motion to support Kepler’s Laws. Students will change the location of the satellite in relation to the sun while studying the path shape and gravitational and velocity vectors associated with orbiting motion. Students will record their findings and present how this information can be used to design their own Farmers Almanac.
• Agricultural Career Marketing: After discussing and defining propaganda and examining examples of marketing flyers or social media campaigns. Students will conduct research on a specific topic such as career options in the agricultural field that make use of satellite technologies. Students identify the training, prior work experiences, and certification processes for these careers. They then create a propaganda flier to advertise this position in the agricultural field and recruit students to see the impact of their marketing plan.
Agricultural Physics Scope and Sequence
Unit 4 - Energy
Length: 7 weeks

Unit Description: Students will explore three different types of mechanical energy: kinetic energy, potential gravitational energy and potential elastic/spring energy as well as conservation of energy, the work-energy theorem and power. Students will begin with analyzing the three common types of mechanical energy (kinetic, potential gravitational, and potential elastic). They will analyze transformation between these types of energy to uncover the conservation of energy theorem. They will continue with analyzing the transformation of work in energy and energy into work in order to uncover the work-energy theorem. Students will also explore the six types of simple machines and their advantages and disadvantages and uncover how to calculate actual mechanical advantage, ideal mechanical advantage and efficiency. Finally, they will uncover that the rate the energy transfers is called power. As a part of this unit, students will also spend time looking at the importance of units and unit conversions in calculations.

Transfer Goals:
• CTE
  o Understand a problem and work to solve it by asking questions, researching information, and testing out ideas until resolved.
  o Work effectively in teams by committing to producing a quality product, taking responsibility for individual roles and timelines, and examining the overall result.
• Science
  o Engage in productive argumentation using evidence to explain phenomena, challenge ideas, and propose solutions to problems.
  o Use mathematical and computational thinking to analyze data to support explanations of phenomena or design solutions to problems.
  o Analyze and interpret data by identifying significant patterns and trends that support valid scientific claims.
• ELA
  o Develop a claim and support it with evidence from the content that can be used to make connections, draw conclusions, and/or advocate for change.
• Technology
  o Use both critical thinking and technology skills to validate information, challenge assumptions, and responsibly share content.

Understandings:
• Each form of energy can be converted into other forms of energy or into work (e.g. kinetic to potential, mechanical to electrical).
• While energy within a system is continually changing forms, and being transferred, the total energy of the system is conserved.

Essential Questions:
• Where does the energy of a system come from? How does it change? Where does it go?
• How can I thoughtfully improve my design based on my data?
• What is thermal energy and how does it transfer?

Unit Standards:

NGSS Performance Expectations:
• HS-PS3-1: Create a computational model to calculate the change in energy of one component in a system when the change in energy of the other components and energy flows in and out of the system are known.

Learning Objectives:
Knowledge and Skills:
• Create and use models to explain how energy transfers within a system.
• Define and describe the various types of energy.

Performance Tasks:
• Farming on Mars: Students map out the energy needs required in their working farm on campus. In this process, they identify 7 key energy sources on the farm to make it completely self-sustainable and potentially portable to another planet. Students generate qualitative energy conservation equations by
• **HS-PS3-2**: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).

• **HS-PS3-3**: Design, build and refine a device that works within the given constraints to convert one form of energy into another form of energy.

• **HS-ETS1-2**: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

**Agricultural and Natural Resources Pathway Standards:**

- **C2.0** Examine the interrelationship between agriculture and the environment.
- **C2.1** Identify important agricultural environmental impacts on soil, water, and air.
- **C2.2** Explain current environmental challenges related to agriculture.

• Mathematically solve for variables with energy and energy conservation.
• Design, build and refine a device that transfers energy.
• Plan and carry out an investigation that relates concepts from motion and forces to energy.
• Analyze and interpret energy diagrams in order to predict what might have caused the energy transformations.
• Differentiate between convection, conduction and radiation.

Completing an energy bar chart analysis of their farm. They will then create an explanatory model of how energy transfers within their farm and use equations to show what changes can be made more efficient and environmentally sustainable. They then use these design principles for sustainability to propose a farm on another planet.

• **Roller Coaster Cars**: Using matchbox cars and track, students will design a lab and test the minimum amount of energy need to get a car around a loop. They will provide models to energy and forces to support their data. They will mathematically solve for velocity, KE and PE at various points on the track, calculate centripetal force and centripetal acceleration at the top of the loop. Students will then complete a lab write up and submit it to their online portfolio.

• **Agricultural Vehicle Design**: Students will read about the energy efficiency of cars that have been engineered to be streamlined. They will then be given a carlike device that is box shaped. Their task is to design a solution to make this vehicle, with a specific agricultural application, more energy efficient. The vehicles will be run down a track, all starting the same height with the same mass, and same size wheels. Data will be used to identify the best design for a vehicle in their given agricultural context.

• **Solar Oven**: With a given list of supplies (recyclables), students will design, build and refine a solar oven to convert light energy into thermal energy for cooking or other agricultural processes. Students will attempt to heat up a set amount of water and quantitatively determine the amount of heat that was transferred to the water. Students will analyze and compare results with other groups within the class to determine which solar oven is the most efficient at heat transfer. Students will then generate an LOL diagram to model the energy flow within the system (system is defined as the water/cup/earth). Students will be provided with a rubric in order to analyze their own results. Students will put their findings in their lab notebook.
# Agricultural Physics Scope and Sequence

## Unit 5 - Momentum

**Length:** 3-4 weeks

### Unit Description:
This unit focuses on Newton's Third Law of Motion, specifically on the resulting change in motion on two objects when they collide, and the effect of an object exploding on the resultant pieces of the object after the explosion. Students will look at the impact of safety features in automobiles (seat belts, air bags, crumple zones) and why they are designed and how their implementation results in less force on the driver. Ultimately, students will apply their understanding of the content to analyze a car crash and present their scientifically based conclusions in a mock trial.

### Transfer Goals:
- **CTE**
  - Work effectively in teams by committing to producing a quality product, taking responsibility for individual roles and timelines, and examining the overall result.
- **Science**
  - Ask or evaluate testable questions that lead to valid explanations of phenomena and solutions to problems.
  - Engage in productive argumentation using evidence to explain phenomena, challenge ideas, and propose solutions to problems.
  - Use mathematical and computational thinking to analyze data to support explanations of phenomena or design solutions to problems.
  - Analyze and interpret data by identifying significant patterns and trends that support valid scientific claims.
- **ELA**
  - Develop a claim and support it with evidence from the content that can be used to make connections, draw conclusions, and/or advocate for change.
- **Technology**
  - Use both critical thinking and technology skills to validate information, challenge assumptions, and responsibly share content.

### Understandings:
- While energy within a system is continually changing forms, and being transferred, the total energy of the system is conserved.
- When two objects within a system collide, the total momentum within the system is conserved.

### Essential Questions:
- What happens when objects collide?
- What is the difference between inertia and momentum?
- What is momentum and how is it conserved?

### Unit Standards:

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<th>NGSS Performance Expectations:</th>
<th>Learning Objectives:</th>
<th>Performance Tasks:</th>
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<tr>
<td><strong>HS-PS2-2:</strong> Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.</td>
<td><strong>Knowledge and Skills:</strong></td>
<td><strong>Animal Welfare:</strong> Students investigate the collision that occur when handling and caring for animals. They use digital simulations to model the forces, energy, and momentum in various situations involving animals. They work to design devices on the farm that can minimize the harm to animals due to collisions.</td>
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<tr>
<td><strong>HS-PS2-3:</strong> Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</td>
<td><strong>Performance Tasks:</strong></td>
<td><strong>Farm Vehicle Crash:</strong> Students will design, build and refine a device to minimize the force experienced during a collision in an</td>
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- **HS-ETS1-2**: Design a solution to a complex real-world problem by breaking it down into smaller more manageable problems that can be solved through engineering.

**Agricultural and Natural Resources Pathway Standards:**
- C3.0 Analyze the effects of technology on agriculture.
- C3.1 Describe how technology affects the logistics of moving an agricultural commodity from producer to consumer.
- C3.2 Understand how technology influences factors such as labor, efficiency, diversity, availability, mechanization, and communication.

- Analyze and interpret data from collisions in order to determine impulse.
- Report data findings both orally and in writing.

In the agricultural context, using predetermined materials and size constraints, students engineer a device that would fit on a guard rail. Using force sensors and dynamic carts and low friction tracks, students will collect data to analyze the effectiveness and compare to the force experienced during a collision without their device present.
Agricultural Physics Scope and Sequence
Unit 6 - Waves
Length: 5-6 weeks

Unit Description: In this unit, students will be able to identify between the wave and particle model for electromagnetic radiation. They will participate in a hands-on lab, conduct online research, and summarize and report out findings. Unit 6 will provide students with the basic understanding of wave types as well as wave properties, with emphasis on the application of sound and electromagnetic waves in society. Electromagnetic radiation may be useful to understanding either a wave or particle model. Radio frequency identification poses advantages and disadvantages to the storage and transmission of information in agricultural contexts.

Transfer Goals:
- CTE
  - Communicate effectively based on who they are talking to, what message they need to share, and what method (e.g., phone call, email, written report) using industry-standard vocabulary.
  - Explore and refine techniques, skills, methods, and processes to create and innovate in an industry.
- Science
  - Ask or evaluate testable questions that lead to valid explanations of phenomena and solutions to problems.
  - Construct and revise explanations about relevant phenomena supported by multiple sources of evidence.
  - Use mathematical and computational thinking to analyze data to support explanations of phenomena or design solutions to problems.
  - Analyze and interpret data by identifying significant patterns and trends that support valid scientific claims.
  - Develop, use, and refine models that represent ideas and communicate relationships to make predictions towards understanding phenomena.
- ELA
  - Work collaboratively by generating ideas and developing a plan that leverages student strengths and allows for individual and team accountability to accomplish a common goal.
- Technology
  - Embrace ambiguity when addressing relevant and authentic issues in a globally connected society.

Understandings:
- When waves encounter objects they can reflect, refract, diffract or absorb depending on the property of material.
- Waves are used in scientific applications and everyday purposes.
- Wavelength, frequency, and amplitude are properties of a wave that determine its characteristics such as pitch, color, sound and energy.
- When waves encounter objects, they can reflect or absorb depending on the property of the material.

Essential Questions:
- How are waves beneficial?
- What are the implications of an object's natural frequency?
- Why are different forms of radiation used for different purposes?
- How is the wave model of light used to describe optical instruments and the creation of optical phenomena such as rainbows?
<table>
<thead>
<tr>
<th>Unit Standards:</th>
<th>Learning Objectives:</th>
<th>Performance Tasks:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NGSS Performance Expectations:</strong></td>
<td><strong>Knowledge and Skills:</strong></td>
<td><strong>Waves Investigation:</strong> Students work on collaborative teams to identify the anatomy of a transverse and longitudinal waves, then plan and carry out an investigation to determine the relationship between frequency and wavelength. The speed of the wave depends on the medium. Students will generate a graph to support that frequency and wavelength are inversely proportion by keeping wave speed constant.</td>
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<tr>
<td>• HS-PS4-1: Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.</td>
<td>• Compare and contrast types of waves.</td>
<td><strong>Electromagnetic Effects on Livestock:</strong> Students will work in collaborative teams to research information about a specific band of different frequencies of electromagnetic waves to determine wavelength, usage in society, and effects on livestock (dangerous vs not dangerous and justify). Using the information from their research, students will generate a poster, infographic or digital display to provide the information to an audience of their peers. Students will share their findings with all groups. As student groups present, the students will then fill out a form to acquire information for all types of electromagnetic waves (jigsaw style).</td>
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<tr>
<td>• HS-PS4-2: Evaluate questions about the advantages of using a digital transmission and storage of information.</td>
<td>• Mathematically solve for variables associated with waves (frequency, period, speed).</td>
<td><strong>Using EM Models to Design a Greenhouse:</strong> Students will look at various scenarios (phenomena of light including refraction, reflection, diffraction, dispersion). Images that promote the wave and particle model of scenarios will be provided. Students will then evaluate claims about the best design principles for a greenhouse and use evidence and reasoning to either support or refute these claims. Last, they use their models to design a greenhouse to promote the most effective growth of plants.</td>
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<tr>
<td>• HS-PS4-3: Evaluate the claims, evidence and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than another.</td>
<td>• Evaluate claims about digital storage and transmission.</td>
<td><strong>RFID Activity:</strong> Students will research the advantages and disadvantages of storing and transmitting agricultural information via Radio-Frequency identification chip. They will form an opinion about RFID use in a population and participate in a Socratic seminar. After conducting their research, students will utilize a teacherrubric to assess their understanding by completing a personal reflection and citing their specific article resources utilizing APA formatting.</td>
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<tr>
<td>• HS-PS4-4: Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.</td>
<td>• Draw conclusions about the dangers of electromagnetic waves.</td>
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<tr>
<td>• HS-ESS1-2: Construct and explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.</td>
<td>• Explain how medium effects wave speed.</td>
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<tr>
<td>AGRICULTURAL AND NATURAL RESOURCES PATHWAY STANDARDS:</td>
<td>• Differentiate between the wave and particle model and assess when to use each.</td>
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<tr>
<td>• C3.0 Analyze the effects of technology on agriculture.</td>
<td>• Describe the outcome of constructive and destructive interference.</td>
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<tr>
<td>• C3.1 Describe how technology affects the logistics of moving an agricultural commodity from producer to consumer.</td>
<td>• Identify and explain the red shift as evidence of the Big Bang Theory.</td>
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<tr>
<td>• C3.2 Understand how technology influences factors such as labor, efficiency, diversity, availability, mechanization, and communication.</td>
<td>• Qualitatively describe and provide examples of diffraction, refraction, dispersion, and reflection.</td>
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<tr>
<td>• C3.3 Conduct short-term research and summarize findings in writing.</td>
<td>• Conduct short-term research and summarize findings in writing.</td>
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<tr>
<td>• C3.4 Complete a standardized lab report.</td>
<td>• Complete a standardized lab report.</td>
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<tr>
<td>• C3.5 Use academic language appropriately.</td>
<td>• Use academic language appropriately.</td>
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# Agricultural Physics Scope and Sequence

## Unit 7 – Electricity and Magnetism

**Length:** 5-6 weeks

<table>
<thead>
<tr>
<th>Unit Description:</th>
<th>This Unit discusses the flow of charge through electric circuits. Students will start off defining the fundamental unit of charge and relate electrical force to other variables, thus using Coulomb’s Law to predict the force acting on a charged particle. The variables which cause and hinder the rate of charge flow (Ohm’s Law) are explained and the mathematical application of electrical principles to series, parallel and combination circuits is presented. Through research while carrying out an engineering task, students will understand the principles that allow for the function of solar cells and DC motors.</th>
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<tr>
<th>Transfer Goals:</th>
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<tbody>
<tr>
<td>• CTE</td>
<td>o Evaluate how business choices impact economic, cultural, and environmental factors to guide decision-making.</td>
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<tr>
<td>• Science</td>
<td>o Ask or evaluate testable questions that lead to valid explanations of phenomena and solutions to problems.</td>
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<td></td>
<td>o Engage in productive argumentation using evidence to explain phenomena, challenge ideas, and propose solutions to problems.</td>
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<td></td>
<td>o Obtain and evaluate relevant, valid, and reliable sources of information in order to effectively communicate through various methods.</td>
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<td></td>
<td>o Develop, use, and refine models that represent ideas and communicate relationships to make predictions towards understanding phenomena.</td>
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<tr>
<td>• ELA</td>
<td>o Develop a claim and support it with evidence from the content that can be used to make connections, draw conclusions, and/or advocate for change.</td>
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<tr>
<td>• Technology</td>
<td>o Efficiently and effectively make sense of large amounts of data and solve complex problems by breaking them down into their component parts.</td>
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<table>
<thead>
<tr>
<th>Understandings:</th>
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<tbody>
<tr>
<td>• Each form of energy can be converted into other forms of energy or into work (e.g. kinetic to potential, mechanical to electrical).</td>
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<tr>
<td>• Energy that is stored in an electric, magnetic, or gravitational field depends upon the position of the objects in the field.</td>
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<tr>
<th>Essential Questions:</th>
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<tbody>
<tr>
<td>• How can we model electrical and magnetic fields?</td>
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<tr>
<td>• What is electricity and what causes it?</td>
<td></td>
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<tr>
<td>• How does electrical energy convert into other forms of energy?</td>
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<table>
<thead>
<tr>
<th>Unit Standards:</th>
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<tbody>
<tr>
<td>NGSS Performance Expectations:</td>
<td></td>
</tr>
<tr>
<td>• HS-PS2-5: Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.</td>
<td>Knowledge and Skills:</td>
</tr>
<tr>
<td></td>
<td>• Identify and explain the fundamental unit of charge.</td>
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<td></td>
<td>• Use field lines to explain and predict the magnitude of force and direction of an electric or magnetic field (related to Coulomb’s Law).</td>
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<tr>
<th>Performance Tasks:</th>
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<tr>
<td>• Solar Vehicles: Using solar cells and commonly available materials, in groups of 3 or 4 students will design, build and refine a device that converts solar energy into mechanical energy. Students will develop a model to explain how solar cells convert light into electrical energy and how a motor works to convert electrical energy into mechanical energy. Students will use these methods to create a solar vehicle.</td>
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<tr>
<td>HS-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.</td>
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<tr>
<td>HS-PS3-3: Design, build and refine a device that works within given constraints to convert one form of energy into another form of energy.</td>
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<tr>
<td>HS-PS3-5: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</td>
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<tr>
<td>HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.</td>
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<tr>
<td>HS-ETS1-3: Evaluate a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</td>
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**Agricultural and Natural Resources Pathway Standards:**

- C2.0 Examine the interrelationship between agriculture and the environment.
- C2.1 Identify important agricultural environmental impacts on soil, water, and air.
- C2.2 Explain current environmental challenges related to agriculture.
- C2.3 Summarize how natural resources are used in agriculture.
- C2.4 Compare and contrast practices for conserving renewable and nonrenewable resources.
- C2.5 Research how new energy sources are developed from agricultural products (e.g., gas cogeneration and ethanol).
- Compare and contrast series and parallel circuits.
- Quantitatively and qualitatively describe variables associated with Ohm’s Law.
- Predict current by manipulating voltage and resistance.
- Describe how a magnet can induce a current.
- Describe how an electrical current can generate a magnetic field.
- Compare and contrast conductors, insulators, and semiconductors.
- Explain how solar energy can be converted into other forms of usable energy.
- Design, build and refine a device to convert solar into mechanical energy.

models to propose solar installations at their farm and across campus.

**Lost Energy on a Farm:** Students will use available tools to analyze DC motors that have been disassembled and explain how the components of a motor function to generate a current. Students will design and build a device that converts mechanical energy into electrical energy. They will measure the current output as well as the ability to power light bulbs. Students will complete a lab report that is used to identify wasted mechanical sources of energy on a farm and propose solutions for how it can be captured.

**Conductivity of Soils:** Students will plan and carry out an investigation how to complete a circuit using various materials of different conductive properties. Rate the brightness of the bulb. Rate which materials have the most electrical resistance. Students will identify the materials that can be best used for measuring the conductivity of soils for crop planting. Students then use instruments to identify the current state of soil on the farm and what amendments are required.