Course Description

The Physics Cherokee Teaching & Learning Standards are designed to continue the student investigations of the physical sciences that began in grades K-8 and provide students the necessary skills to be proficient in physics. These standards include more abstract concepts such as nuclear decay processes, interactions of matter and energy, velocity, acceleration, force, energy, momentum, properties and interactions of matter, electromagnetic and mechanical waves, and electricity, magnetism, and their interactions. Students investigate physics concepts through experiences in laboratories and field work using the science and engineering practices,

Science standards integrate the three dimensions of **Science and Engineering Practices (SEPs)**, **Crosscutting Concepts (CCCs)**, and **Disciplinary Core Ideas (DCIs)** to provide a comprehensive framework that emphasizes active engagement, interdisciplinary connections, and core scientific principles. Together, they show how science standards engage *students* in obtaining, evaluating, and communicating information.

Science and Engineering Practices	Crosscutting Concepts	Disciplinary Core Ideas
Asking Questions (Science) and Defining Problems (Engineering)	Patterns	Engineering, Technology, and the Application of Science (TLS)
Developing and Using Models	Cause and Effect: Mechanism and Explanation	
Planning and Carrying Out Investigations	Scale, Proportion, and Quantity	Physical Science (P)
Analyzing and Interpreting Data	Systems and System Models	
Mathematics and Computational Thinking	Energy and Matter: Flows, Cycles, and Conservation	Life Science (L)
Constructing Explanations (Science) and Designing Solutions (Engineering)		
Engaging in Argument from Evidence	Structure and Function	Earth and Space Science (E)
Obtaining, Evaluating, and Communicating Information	Stability and Change	

Science and Engineering Practices are fundamental approaches that scientists and engineers use to investigate the natural world and solve practical problems. **Crosscutting Concepts** in science are overarching themes that bridge various disciplines, helping students and researchers see connections and deepen their understanding of the natural world. **Disciplinary Core Ideas** are fundamental concepts that students need to understand to develop a deep knowledge of science across various disciplines.

Thinking Like a Scientist

Thinking Like a Scientist standards represent scientific thinking skills that should be incorporated throughout the entire course.

Overarching Standard

TLS9-12: Refine scientific inquiry skills by designing and conducting investigations, applying scientific theories, critically evaluating scientific literature, and contributing to scientific discussions.

Supporting Standards for Student Mastery

TLS9-12.a: Use specialized scientific terms and concepts to analyze and explain scientific phenomena.

TLS9-12.b: Design and conduct independent experiments with multiple variables.

TLS9-12.c: Utilize advanced tools and statistical methods for data analysis.

TLS9-12.d: Communicate complex findings through reports and presentations.

Semester 1 (August – December)

Unit 1: 1-D Kinematics (3-4 weeks)

In this introductory unit, students will explore the fundamentals of one-dimensional kinematics, focusing on the relationship between distance, displacement, speed, velocity, and acceleration as functions of time. They will plan and carry out investigations to complete calculations and apply kinematic equations to scenarios. Students will also analyze one-dimensional motion problems and interpret data through motion graphs to illustrate relationships. They will ask questions to compare and contrast scalar and vector quantities, building a solid foundation in understanding the principles of kinematics.

Overarching Standard for Unit 1

P1: Obtain, evaluate, and communicate information about the relationship between distance, displacement, speed, velocity, and acceleration as functions of time.

P1.a: Plan and carry out an investigation of one-dimensional motion to calculate average and instantaneous speed and velocity.
- Analyze one-dimensional problems involving changes of direction, using algebraic signs to represent vector direction.
- Apply one-dimensional kinematic equations to situations with no acceleration, and positive, or negative constant acceleration.

Supporting Standards for Student Mastery in Unit 1

P1.b: Analyze and interpret data using created or obtained motion graphs to illustrate the relationships among position, velocity, and acceleration, as functions of time.

P1.c: Ask questions to compare and contrast scalar and vector quantities.

Unit 2: 2-D Kinematics (2-3 weeks)

In this unit, students will investigate the principles of two-dimensional kinematics, focusing on the behavior of objects in motion with constant acceleration. They will analyze and interpret data related to two-dimensional motion by breaking vectors into their x and y components and applying kinematic equations to predict and describe projectile motion. Students will design experiments to investigate projectile motion, learning to calculate key parameters. By resolving vectors and understanding independent motion along with coordinate axes, students will deepen their understanding of how initial conditions influence the trajectory of moving objects.

Overarching Standard for Unit 2

P1: Obtain, evaluate, and communicate information about the relationship between distance, displacement, speed, velocity, and acceleration as functions of time.

P1.d: Analyze and interpret data of two-dimensional motion with constant acceleration.

- Resolve position, velocity, or acceleration vectors into components (x and y, horizontal and vertical).
- Add vectors graphically and mathematically by adding components.
- Interpret problems to show that objects moving in two dimensions have independent motions along each coordinate axis.
- Design an experiment to investigate the projectile motion of an object by collecting and analyzing data using kinematic equations.
- Predict and describe how changes to initial conditions affect the resulting motion.
- Calculate range and time in the air for a horizontally launched projectile.

Supporting Standards for Student Mastery in Unit 2

P1.c: Ask questions to compare and contrast scalar and vector quantities.

Unit 3: Dynamics – Newton's Laws & Forces (4-5 weeks)

In this unit, students will explore the fundamental concepts of dynamics through Newton's Laws of Motion and investigate how forces impact the acceleration and motion of objects. They will also develop and use Free Body Diagrams to represent forces acting on objects in both equilibrium and non-equilibrium situations. Additionally, students will apply mathematical methods to determine the magnitudes and directions of forces such as gravitational, normal, frictional, tension, and spring forces.

Overarching Standard for Unit 3

P2: Obtain, evaluate, and communicate information about how forces affect the motion of objects.

P2.a: Construct an explanation based on evidence using Newton's Laws of how forces affect the acceleration of a body.

- Explain and predict the motion of a body in absence of a force and when forces are applied using Newton's 1st Law (principle of inertia).
- Calculate the acceleration for an object using Newton's 2nd Law, including situations where multiple forces act together.
- Identify the pair of equal and opposite forces between two interacting bodies and relate their magnitudes and directions using Newton's 3rd Law.

Supporting Standards for Student Mastery in Unit 3

P2.b: Develop and use a model of a Free Body Diagram to represent the forces acting on an object (both equilibrium and non-equilibrium).

P2.c: Use mathematical representations to calculate magnitudes and vector components for typical forces including gravitational force, normal force, friction forces, tension forces, and spring forces.

Unit 4: Gravitation & Circular Motion (2-3 weeks)

In this introductory unit, students will learn the fundamental concepts of gravitation and circular motion by investigating how forces affect objects moving in a circular path. Using Newton's Universal Law of Gravitation, students will develop and use models to understand the mathematical relationships between mass, distance, and gravitational force. They will plan and carry out investigations to calculate centripetal acceleration and identify the force responsible for maintaining circular motion, enhancing their comprehension of how gravitational and centripetal forces influence the movement of objects.

Overarching Standard for Unit 4

P2: Obtain, evaluate, and communicate information about how forces affect the motion of objects.

P2.d: Plan and carry out an investigation to gather evidence to identify the force or force component responsible for causing an object to move along a circular path.

- Calculate the magnitude of a centripetal acceleration.

Supporting Standards for Student Mastery in Unit 4

P2.e: Develop and use a model to describe the mathematical relationship between mass, distance, and force as expressed by Newton's Universal Law of Gravitation.

Unit 5: Energy (3-4 weeks)

In this unit, students will examine the principles of energy conservation and its application in physical systems. They will investigate how the conservation of mechanical energy and linear momentum helps predict system behavior. Students will engage in experiments to demonstrate energy conservation and the rate of energy transfer (power) within closed systems. By comparing open and closed systems, they will gain insight into the differences in energy dynamics. Additionally, students will use mathematical and computational methods to apply the Work-Kinetic Energy Theorem and analyze energy transformations.

Overarching Standard for Unit 5

P3: Obtain, evaluate, and communicate information about the importance of conservation laws for mechanical energy and linear momentum in predicting the behavior of physical systems.

P3.c: Plan and carry out an investigation demonstrating conservation and rate of transfer of energy (power) to solve problems involving closed systems.

Supporting Standards for Student Mastery in Unit 5

P3.a: Ask questions to compare and contrast open and closed systems.

P3.b: Use mathematics and computational thinking to analyze, evaluate, and apply the principle of conservation of energy and the Work-Kinetic Energy Theorem.

Semester 2 (January – May)

Unit 6: Momentum (2-3 weeks)

In this unit, students will explore the concept of momentum and its role in understanding motion and collisions. They will apply Newton's Laws to explain how forces influence the acceleration of objects and how momentum is conserved during interactions. Students will engage in experiments and problem-solving activities to calculate momentum, analyze collisions, and evaluate the effects of various forces. By investigating the principle of conservation of momentum, they will deepen their understanding of physical systems and apply these concepts to both theoretical and practical scenarios.

Overarching Standard for Unit 6

P2: Obtain, evaluate, and communicate information about how forces affect the motion of objects.

P2.a: Construct an explanation based on evidence using Newton's Laws of how forces affect the acceleration of a body.

- Explain and predict the motion of a body in absence of a force and when forces are applied using Newton's 1st Law (principle of inertia).
- Calculate the acceleration for an object using Newton's 2nd Law, including situations where multiple forces act together.
- Identify the pair of equal and opposite forces between two interacting bodies and relate their magnitudes and directions using Newton's 3rd Law.

Supporting Standards for Student Mastery in Unit 6

P3.a: Ask questions to compare and contrast open and closed systems.

P3.b: Use mathematics and computational thinking to analyze, evaluate, and apply the principle of conservation of energy and the Work-Kinetic Energy Theorem.

Unit 7: Electrostatics (2-3 weeks)

In this unit, students will study the fundamental principles of electrostatics, focusing on the behavior of electric charges and their interactions. They will investigate how electric potential energy is influenced by the presence and movement of charges. Through mathematical modeling and diagrams, students will compare electric forces to gravitational forces and examine the processes of charge transfer. By conducting experiments and analyzing data, they will develop a deeper understanding of electrostatic phenomena and their applications in various contexts.

Overarching Standard for Unit 7

P5: Obtain, evaluate, and communicate information about electrical and magnetic force interactions.

P5.c: Construct an explanation based on evidence of the behavior of charges in terms of electric potential energy.

Supporting Standards for Student Mastery in Unit 7

P5.a: Develop and use mathematical models and generate diagrams to compare and contrast the electric and gravitational forces between two charged objects.

P5.b: Plan and carry out investigations to demonstrate and qualitatively explain charge transfer by conduction, friction, and induction.

Unit 8: Circuits & Magnetism (2-3 weeks)

In this unit, students will examine the principles of circuits and magnetism, focusing on the interplay between electric currents and magnetic fields. They will investigate how electric currents generate magnetic fields and how these interactions are crucial for the functioning of motors and generators. Students will conduct experiments to understand the significance of coils in electrical devices and explore the properties and behavior of electromagnetic waves. Through hands-on activities and data analysis, students will gain insights into the foundational concepts of electromagnetism and its practical applications.

Overarching Standard for Unit 8

P5: Obtain, evaluate, and communicate information about electrical and magnetic force interactions.

P5.e: Plan and carry out investigations to clarify the relationship between electric currents and magnetic fields.

(*Clarification statement*: This includes coils and their importance in the design of motors and generators.)

Supporting Standards for Student Mastery in Unit 8

P4.d: Plan and carry out investigations to characterize the properties and behavior of electromagnetic waves.

(*Clarification statement*: Properties of waves include, but not limited to, amplitude, frequency, wavelength, and the relationship between frequency or wavelength and the energy of the wave.)

Unit 9: Waves: Mechanical & Sound (4-5 weeks)

In this unit, students will explore the fundamental properties and behaviors of mechanical and sound waves, including how waves interact with their environment. They will develop and use mathematical models to explain how mechanical waves propagate, emphasizing the relationships between velocity, frequency, and wavelength. Students will also analyze sound waves to gain insight into the production and characteristics of sound.

Overarching Standard for Unit 9

P4: Obtain, evaluate, and communicate information about the properties and applications of waves.

P4.a: Develop and use mathematical models to explain mechanical and electromagnetic waves as a propagating disturbance that transfers energy.
(*Clarification statement*: Mathematically describe how the velocity, frequency, and wavelength of a propagating wave are related.)

Supporting Standards for Student Mastery in Unit 9

P4.b: Develop and use models to describe and calculate characteristics related to the interference and diffraction of waves (single and double slits).

P4.c: Construct an argument that analyzes the production and characteristics of sounds waves.
(*Clarification statement*: Includes, but not limited to, Doppler Effect, standing waves, wavelength, the relationship between amplitude and the energy of the wave, and the relationship between frequency and pitch.)

Unit 10: EMS Color & Optics (4-5 weeks)

In this unit, students will investigate the properties and applications of electromagnetic waves, focusing on color and optics. They will develop and use mathematical models to explain how electromagnetic waves propagate, including the relationships between velocity, frequency, and wavelength. Through investigations, students will describe common features of light and analyze aspects of reflection and refraction of light waves using optical ray diagrams and calculations related to lenses. Additionally, students will investigate the behavior of electromagnetic waves and changes in diffraction patterns associated with geometry and wavelength.

Overarching Standard for Unit 10

P4: Obtain, evaluate, and communicate information about the properties and applications of waves.

P4.a: Develop and use mathematical models to explain mechanical and electromagnetic waves as a propagating disturbance that transfers energy.
(*Clarification statement*: Mathematically describe how the velocity, frequency, and wavelength of a propagating wave are related.)

P4.e: Plan and carry out investigations to describe common features of light in terms of color, polarization, spectral composition, and wave speed in transparent media.

- Analyze experimentally and mathematically aspects of reflection and refraction of light waves and describe the results using optical ray diagrams.
- Perform calculations related to reflections from plane surfaces and focusing using thin lenses.

Supporting Standards for Student Mastery in Unit 10

P4.d: Plan and carry out investigations to characterize the properties and behavior of electromagnetic waves.
(*Clarification statement*: Properties of waves include, but not limited to, amplitude, frequency, wavelength, and the relationship between frequency or wavelength and the energy of the wave.)

P4.f: Plan and carry out investigations to identify the behavior of light using lenses.
(*Clarification statement*: Investigations concerning Snell's Law, optical ray diagrams, and thin lens equation should be conducted.)

P4.g: Plan and carry out investigations to describe changes in diffraction patterns associated with geometry and wavelength for mechanical and electromagnetic waves.

Unit 11: Nuclear (1-2 weeks)

In this unit, students will explore the fundamental concepts of nuclear physics and the technological applications of nuclear processes. They will develop and use models to explain, compare, and contrast nuclear processes such as radioactive decay, fission, and fusion. Students will investigate the mechanisms and characteristics of different types of radioactive decay and their effects. Additionally, they will use mathematical models to calculate the amount of a substance present after a given time based on its half-life, relating this to the law of conservation of mass and energy.

Overarching Standard for Unit 11

P6: Obtain, evaluate, and communicate information about nuclear changes of matter and related technological applications.

P6.a: Develop and use models to explain, compare, and contrast nuclear processes including radioactive decay, fission, and fusion.

Supporting Standards for Student Mastery in Unit 11

P6.b: Construct an argument to compare and contrast mechanisms and characteristics of radioactive decay. (*Clarification statement*: Include alpha, beta, and gamma decays and their effects.)

P6.c: Develop and use mathematical models and representations to calculate the amount of substance present after a given amount of time based on its half-life and relate this to the law of conservation of mass and energy.