Curriculum at a Glance

Physics Honors

Level: 400

Grades 11 and 12

Students in Physics Honors study basics of mechanics, electromagnetism and optics. Within mechanics the topics of kinematics, dynamics, and conservation principles (momentum & energy) are investigated. These mechanics topics are then extended into the realm of electric and magnetic phenomena. Finally, the behavior of light and its interaction with materials is covered. Students are expected to develop factual knowledge of all topics, as well as create a conceptual framework to connect ideas. Mathematical analysis is limited to algebraic, graphical, geometric, and trigonometric principles. A significant amount of class time is devoted to experimental investigation consisting of laboratory design, data collection and analysis. Students taking Physics Honors also have an opportunity to concurrently enroll in the University of Connecticut's Early College Experience program and earn up to eight college credits in Physics.

Unit Name	Essential Content
Introduction	• Demonstrate an understanding of basic SI units, SI prefixes and scientific notation. • Describe the processes of the scientific method. • Describe the role of models and diagrams in physics. • Synthesize data in tables and graphs to create equations that explain these relationships. • Analyze graphs to discover relationships between physics quantities
Describing Motion: Kinematics in One Dimension	• Identify the fundamental quantities of kinematics – position, time, duration, distance, displacement, speed, velocity, and acceleration. • Construct and analyze graphs of position vs. time and velocity vs. time.

	• Solve kinematics equations for displacement, time, or velocity under conditions of zero or non-zero constant acceleration (including free fall). • Recognize that the difference between average and instantaneous velocity and acceleration occurs when Δt approaches zero.
Kinematics in Two Dimension	• Define, and analytically work with, vector and scalar quantities. • Relate the two dimensional motion of a projectile to the sum of the horizontal motion plus the vertical motion. • Describe situations in terms of frame of reference and relative velocities • Solve complex vector addition and subtraction problems of three or more vectors at various, non perpendicular angles. • Solve simple and complex projectile problems.
Motion and Force: Dynamics	• Show an understanding that all forces exist because of the interaction of two systems. • Define net force and equilibrium. • Identify that the mass of an abject is the measure of its inertia • Define weight, tension, and normal force • Define two types of friction, both conceptually and mathematically. • Classify different forces as “action/reaction” pairs. • Construct free-body diagrams by correctly identifying all the forces on an object. • Determine the net external force on an object.. • Apply knowledge of Newton’s Second Law to solve problems involving forces, mass, accelerations, motion, and friction.
Circular Motion: Gravitation	• Demonstrate an understanding conceptually and mathematically that every object with mass exerts a gravitational force on every other object. • Solve problems involving centripetal acceleration and force. • Explain how the apparent existence of an outward force in circular motion can be explained as

	inertia resisting centripetal force. ● Explain how Newton's law of Universal Gravity accounts for various phenomena, including planetary orbits and falling objects. ● Describe Kepler's Law of Planetary Motion. ● Apply Newton's Law of Gravity to the solving of problems.
Work and Energy	● Define and identify work by relating it to force and displacement. ● Define power be relating it to work and time. ● Demonstrate an understanding that energy cannot be created or destroyed, but only changed from one form to another. ● Identify the factors that affect an object's kinetic energy. ● Identify the factors that affect an object's potential energy. ● Calculate the net work and power when many forces are applied to an object. ● Solve problems using conservation of mechanical energy. ● Apply the work–kinetic energy theorem to solve problems. ● Recognize the forms that conserved energy can take. ● Solve complex problems using the Law of Conservation of Energy.
Linear Momentum	● Define momentum and impulse. ● State the law of conservation of momentum. ● Explain that impulses produce changes in momentum. ● Describe the total momentum of two objects before and after they interact. ● Analyze and distinguish between elastic and inelastic collisions. ● Apply the knowledge of conservation of momentum to solve real world problems. ● Solve complex collisions using both the conservation of energy and momentum.
Electric charge and Electric Field	● Define Coulomb's Law ● Explain the concept of electric field

	● Sketch the electric field pattern in the region between charged objects ● Determine the net electric field at a point some distance from two or more point charges. ● Determine the electric force on a charged particle in an electric field.
Electric Potential and Electric Energy; Capacitance	● Define electric potential. ● Solve problems involving electric potential difference. ● Develop different relationships when solving problems relating to electric potential difference. ● Understand the relationship between electrical potential and electrical energy. ● Develop an understanding of the purpose of capacitors in an electrical circuit. ● Recognize electrical energy as another form of potential energy. ● Predict how energy from a capacitor is transferred into a circuit.
Electric Currents	● Explain the workings of a simple battery. ● Solve problems relating current, charge and time. ● Calculate resistance, current and potential difference using Ohm's Law. ● Define and use the concept of electric power. ● Recognize the factors that affect the resistance in a wire. ● Evaluate the importance of electrical resistance in our modern society.
DC Circuits	● Demonstrate an understanding that electric circuits provide a means of transferring electrical energy when heat, light, sound or chemical changes are produced. ● Interpret and construct circuit diagrams. ● Calculate the equivalent resistance for a circuit of resistors in series and parallel and find the current in and potential across each resistor in the circuit. ● Calculate the equivalent capacitance for a circuit of capacitors in series and parallel and find the current in and potential across each capacitor in the circuit. ● Use Kirchhoff's Rules to calculate the current, potential drop in various resistors in a complex circuit.

	● Evaluate how the type of circuit affects the current and potential difference of various elements that are connected to that circuit.
Magnetism	● Identify that electric currents and magnets exert a force on each other. ● Describe the magnetic field around a permanent magnet ● Describe the orientation of the Earth's magnetic field. ● Describe the magnetic field produced by a current in a straight conductor or solenoid. ● Solve problems involving moving charges in the presence of magnetic fields. ● Solve problems involving current carrying wires in the presence of magnetic fields.
Light: Geometric Optics	● Define reflection and refraction of light ● Identify created images as real or virtual. ● Solve problems of image location and magnification using the mirror equation and the thin lens equation. ● Solve problems using Snell's Law ● Use ray diagrams to find the position of an image produced by converging or diverging mirrors and lenses. ● Explain dispersion and phenomena such as rainbows in terms of the relationship between index of refraction and the wavelength. ● Evaluate the consequences of total internal reflection.