Connecticut State Department of Education

Science Curriculum Standards

High School Grades 9-12

Essential Questions

Energy Transformations - Energy Transfer and Transformations

What is the role of energy in our world?

Chemical Structures and Properties – Properties of Matter

How does the structure of matter affect the properties and uses of materials?

Global Interdependence – The Changing Earth

How do materials cycle through the Earth's systems?

Cell Chemistry and Biotechnology – Structure and Function

How are organisms structured to ensure efficiency and survival?

Genetics, Evolution and Biodiversity – Heredity and Evolution

What processes are responsible for life's unity and diversity?

Energy Transformations - Science and Technology in Society

Chemical Structures and Properties - Science and Technology in Society

Chemical Structures and Properties - Science and Technology in Society

Global Interdependence – Science and Technology in Society

Cell Chemistry and Biotechnology – Science and Technology in Society

Genetics, Evolution and Biodiversity - Science and Technology in Society

How do science and technology affect the quality of our lives?

Science Core Standards

SCIENTIFIC INQUIRY (used in all high school courses)

- Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena.
- Scientific inquiry progresses through a continuous process of questioning, data collection, analysis and interpretation.
- Scientific inquiry requires the sharing of findings and ideas for critical review by colleagues and other scientists.

SCIENTIFIC LITERACY (used in all high school courses)

- Scientific literacy includes the ability to read, write, discuss and present coherent ideas about science.
- Scientific literacy also includes the ability to search for and assess the relevance and credibility of scientific information found in various print and electronic media.

SCIENTIFIC NUMERACY (used in all high school courses)

Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data and ideas.

Students will identify questions that can be answered through scientific investigation.

Students will read, interpret and examine the credibility and validity of scientific claims in different sources of information.

Students will formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

Students will design and conduct appropriate types of scientific investigations to answer different questions.

Students will identify independent and dependent variables, including those that are kept constant and those used as controls.

Students will use appropriate tools and techniques to make observations and gather data.

Students will assess the reliability of the data that was generated in the investigation.

Students will use mathematical operations to analyze and interpret data, and present relationships between variables in appropriate forms.

Students will articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.

Students will communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

Energy Transformations - Energy Transfer and Transformations
Energy cannot be created or destroyed; however, energy can be converted from one form to another.

Students will describe the effects of adding energy to matter in terms of the motion of atoms and molecules, and the resulting phase changes.

Students will explain how energy is transferred by conduction, convection and radiation.

Students will describe energy transformations among heat, light, electricity and motion.

The electrical force is a universal force that exists between any two charged objects.

Students will explain the relationship among voltage, current and resistance in a simple series circuit.

Students will explain how electricity is used to produce heat and light in incandescent bulbs and heating elements.

Students will describe the relationship between current and magnetism.

Energy Transformations - Science and Technology in Society
Various sources of energy are used by humans and all have advantages and disadvantages.

Students will explain how heat is used to generate electricity.

Students will describe the availability, current uses and environmental issues related to the use of fossil and nuclear fuels to produce electricity.

Students will describe the availability, current uses and environmental issues related to the use of hydrogen fuel cells, wind and solar energy to produce electricity.

Chemical Structures and Properties – Properties of Matter
Atoms react with one another to form new molecules.

Students will describe the general structure of the atom, and explain how the properties of the first 20 elements in the Periodic Table are related to their atomic structures.

Students will describe how atoms combine to form new substances by transferring electrons (ionic bonding) or sharing electrons (covalent bonding).

Students will explain the chemical composition of acids and bases, and explain the change of pH in neutralization reactions.

Due to its unique chemical structure, carbon forms many organic and inorganic compounds.

Students will explain how the structure of the carbon atom affects the type of bonds it forms in organic and inorganic molecules.

Students will describe combustion reactions of hydrocarbons and their resulting by-products.

Students will explain the general formation and structure of carbon-based polymers, including synthetic polymers, such as polyethylene, and biopolymers, such as carbohydrate.

Chemical Structures and Properties - Science and Technology in Society
Chemical technologies present both risks and benefits to the health and well-being of humans, plants and animals.

Students will explain how simple chemical monomers can be combined to create linear, branched and/or cross-linked polymers.

Students will explain how the chemical structure of polymers affects their physical properties.

Students will explain the short- and long-term impacts of landfills and incineration of waste materials on the quality of the environment.

Global Interdependence – The Changing Earth
Elements on Earth move among reservoirs in the solid earth, oceans, atmosphere and organisms as part of biogeochemical cycles.

Students will explain how chemical and physical processes cause carbon to cycle through the major earth reservoirs.

Students will explain how solar energy causes water to cycle through the major earth reservoirs.

Students will explain how internal energy of the Earth causes matter to cycle through the magma and the solid earth.

Global Interdependence – Science and Technology in Society
The use of resources by human populations may affect the quality of the environment.

Students will explain how the release of sulfur dioxide (SO_2) into the atmosphere can form acid rain, and how acid rain affects water sources, organisms and human-made structures.

Students will explain how the accumulation of carbon dioxide (CO_2) in the atmosphere increases Earth's "greenhouse" effect and may cause climate changes.

Students will explain how the accumulation of mercury, phosphates and nitrates affects the quality of water and the organisms that live in rivers, lakes and oceans.

Some materials can be recycled, but others accumulate in the environment and may affect the balance of the Earth systems.

Students will explain how land development, transportation options and consumption of resources may affect the environment.

Students will describe human efforts to reduce the consumption of raw materials and improve air and water quality.

Cell Chemistry and Biotechnology – Structure and Function
Fundamental life processes depend on the physical structure and the chemical activities of the cell.

Students will describe significant similarities and differences in the basic structure of plant and animal cells.

Students will describe the general role of DNA and RNA in protein synthesis.

Students will describe the general role of enzymes in metabolic cell processes.

Students will explain the role of the cell membrane in supporting cell functions.

Cell Chemistry and Biotechnology – Science and Technology in Society
Microorganisms have an essential role in life processes and cycles on Earth.

Students will describe the similarities and differences between bacteria and viruses.

Students will describe how bacterial and viral infectious diseases are transmitted, and explain the roles of sanitation, vaccination and antibiotic medications in the prevention and treatment of infectious diseases.

Students will explain how bacteria and yeasts are used to produce foods for human consumption.

Similarities in the chemical and structural properties of DNA in all living organisms allow the transfer of genes from one organism to another.

Students will describe, in general terms, how the genetic information of organisms can be altered to make them produce new materials.

Students will explain the risks and benefits of altering the genetic composition and cell products of existing organisms.

Genetics, Evolution and Biodiversity – Heredity and Evolution
In sexually reproducing organisms, each offspring contains a mix of characteristics inherited from both parents.

Students will explain how meiosis contributes to the genetic variability of organisms.

Students will use the Punnet Square technique to predict the distribution of traits in mono- and di-hybrid crossings.

Students will deduce the probable mode of inheritance of traits (e.g., recessive/dominant, sex-linked) from pedigree diagrams showing phenotypes.

Students will describe the difference between genetic disorders and infectious diseases.

Evolution and biodiversity are the result of genetic changes that occur over time in constantly changing environments.

Students will explain how the processes of genetic mutation and natural selection are

related to the evolution of species.

Students will explain how the current theory of evolution provides a scientific explanation for fossil records of ancient life forms.

Students will describe how structural and behavioral adaptations increase the chances for organisms to survive in their environments.

Genetics, Evolution and Biodiversity - Science and Technology in Society
Living organisms have the capability of producing populations of unlimited size, but the environment can support only a limited number of individuals from each species.

Students will describe the factors that affect the carrying capacity of the environment.

Students will explain how change in population density is affected by emigration, immigration, birth rate and death rate, and relate these factors to the exponential growth of human populations.

Students will explain how technological advances have affected the size and growth rate of human populations throughout history.

Enrichment Science Standards
Physics
Motion and Forces
Newton's laws predict the motion of most objects

When forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest.

The law $F = ma$ is used to solve motion problems that involve constant forces.

When one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction.

Applying a force to an object perpendicular to the direction of its motion causes the object to change direction.

Circular motion requires the application of a constant force directed toward the center of the circle.

Newton's laws are not exact but provide very good approximations unless an object is small enough that quantum effects become important.

Conservation of Energy and Momentum

The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects

Kinetic energy can be calculated by using the formula E = (1/2)mv2.

Changes in gravitational potential energy near Earth can be calculated by using the formula (change in potential energy) = *mgh.*

Momentum is calculated as the product *mv.*

Momentum is a separately conserved quantity different from energy.

An unbalanced force on an object produces a change in its momentum.

The principles of conservation of momentum and energy can be used to solve problems involving elastic and inelastic collisions.

Heat and Thermodynamics
Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat

Heat flow and work are two forms of energy transfer between systems.

The work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature.

The internal energy of an object includes the energy of random motion of the object's atoms and molecules. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.

Most processes tend to decrease the order of a system over time, so that energy levels are eventually distributed more uniformly.

Waves
Waves have characteristic properties that do not depend on the type of wave

Waves carry energy from one place to another.

Transverse and longitudinal waves exist in mechanical media, such as springs and ropes, and in the earth as seismic waves.

Wavelength, frequency, and wave speed are related.

Sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.

Radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3×10^8m/s, and less when passing through other media.

Waves have characteristic behaviors such as interference, diffraction, refraction and polarization.

Beats and the Doppler Effect result from the characteristic behavior of waves.

Electric and Magnetic Phenomena
Electric and magnetic phenomena are related and have many practical applications.

The voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors can be predicted using Ohm's law.

Any resistive element in a DC circuit dissipates energy, which heats the resistor.

The power in any resistive circuit element can be calculated by using the formula Power $= 1^2R$.

Charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges.

Magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources.

Changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.

Plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity.