FOREST HILLS SCHOOL DISTRICT

SCIENCE

COURSE OF STUDY

Approved by the Forest Hills Board of Education
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FOREST HILLS SCHOOL DISTRICT

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Program Philosophy and Goals

The science program in Forest Hills empowers students to become scientifically literate global citizens through inquiry based learning opportunities. The Forest Hills science program encourages curiosity, collaboration, problem solving and critical thinking that will lead to a well-rounded graduate who is fully prepared for future career pathways. Students will build upon a foundation of scientific concepts and real-world applications. Forest Hills students will be provided with opportunities to explore science, engineer creative solutions to authentic challenges, and become informed decision makers.

We believe in a nurturing, personalized environment that engages and empowers ALL learners through instruction that:

- Establishes clear scientific goals to focus learning.
- Implements tasks that promote reasoning, problem solving and curiosity.
- Facilitates meaningful scientific discourse.
- Analyzes explanations and models using principles of engineering, mathematics, and scientific reasoning.
- Engages students to take ownership of their learning while posing purposeful questions.
- Supports inquiry, risk taking, and problem solving.
- Encourages flexible and creative problem solving approaches to spark curiosity and inquiry.

FHSD Science Students will...

- ➢ Ask questions based on observable events in the natural world with increasing complexity.
- ➢ Plan and design models, conduct scientific experiments or investigations.
- ➢ Use tools and techniques to collect, analyze, and interpret data and create testable hypotheses.
- ➢ Collaborate with peers to solve problems and ask questions.
- ➢ Think critically to obtain and evaluate evidence, construct explanations, draw conclusions, or design solutions.
- ➢ Communicate and support scientific evidence and evaluate explanations and conclusions.
- ➢ Understand that science is constantly evolving as we acquire more information.
- ➢ Consider themselves as scientists who understand science, deploy and engineer solutions, and contribute to the field of science.

All FHSD science instruction is rooted in Ohio's Cognitive Demands for Science. The cognitive demands include designing technological and engineering solutions using science concepts, demonstrating science knowledge, interpreting and communicating science concepts and recalling accurate science.

COGNITIVE DEMAND	DESCRIPTION
DESIGNING TECHNOLOGICAL/ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS (T)	Requires student to solve science-based engineering or technological problems through application of scientific inquiry. Within given scientific constraints, propose or critique solutions, analyze and interpret technological and engineering problems, use science principles to anticipate effects of technological or engineering design, find solutions using science and engineering or technology, consider consequences and alternatives, and/or integrate and synthesize scientific information.
DEMONSTRATING SCIENCE KNOWLEDGE (D)	Requires student to use scientific practices and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather and organize data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments. (Slightly altered from National Science Education Standards)
INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS (C)	Requires student to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.
RECALLING ACCURATE SCIENCE (R)	Requires student to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures (being able to describe how) and basic principles.

As with all other frameworks and cognitive demand systems, Ohio's system has overlap between the categories. *Recalling Accurate Science* is a part of the other three cognitive demands included in Ohio's framework, because science knowledge is required for students to demonstrate scientific literacy.

Kindergarten Science

Students will develop the skills for systematic discovery to understand the science of the natural world around them in greater depth by using scientific inquiry. Students will learn about weather and how we experience daily and seasonal changes. Students will investigate that living and nonliving things have specific physical properties, and they can be used to sort and classify into categories. Students will discover that the survival of living things is dependent on specific characteristics, traits, and behaviors.

Area of Science: Earth and Space Daily and Seasonal Changes
In this unit students will learn: 1. We experience daily and seasonal changes in weather. 2. The sun, moon, and stars change daily and seasonally.
Standards
● Weather changes are long-term and short-term. ● The moon, sun, and stars can be observed at different times of the day or night.

Area of Science: Physical Science Properties of Everyday Objects and Materials
In this unit students will learn: 1. Scientists make observations about the properties of objects and materials. 2. Properties of objects and materials can be compared and grouped. 3. Objects and materials can make sound in different ways based on their properties.
Standards
● Objects and materials can be sorted and described by their properties. ● Some objects and materials can be made to vibrate and produce sound.

Area of Science: Life Science Physical and Behavioral Traits of Living Things
In this unit students will learn: 1. The survival of living things is dependent on specific characteristics, traits, and behaviors.
Standards
● Living things have specific characteristics and traits. ● Living things have physical traits and behaviors, which influence their survival.

First Grade Science

Students will develop a sense of wonder about the world around them through conducting hands-on experiments, participating in collaborative problem solving, and real world experiences. Students will explore earth and space science, physical science, and life science. Through these topics, students will understand how energy is observed through movement, heating, cooling, and the needs of living organisms.

Area of Science: Earth and Space
Sun, Energy and Weather

In this unit students will learn:

1. Sunlight affects Earth's land, air, and water through the process of heating or cooling them.
2. The properties of water can change from a solid to a liquid, and from a liquid to a solid.

Standards

- The sun is the principal source of energy.
- Water on Earth is present in many forms.

Area of Science: Physical Science
Motion and Materials

In this unit students will learn:

1. Objects and materials can change when exposed to energy. Energy causes temperatures to heat up and cool down.
2. The position of an object is the result of a pushing or pulling force on that object.

Standards

- Properties of objects and materials can change.
- Objects can be moved in a variety of ways, such as straight, zigzag, circular and back and forth.

Area of Science: Life Science
Basic Needs of Living Things

In this unit students will learn:

1. All living things need energy, nutrients, water, shelter and air to survive.
2. All living things have different environments that meet their specific needs to survive.
3. Energy can be derived from the sun or food.

Standards

- Living things have basic needs, which are met by obtaining materials from the physical environment.
- Living things survive only in environments that meet their needs.

Second Grade Science

Students will focus on observations of the environment. Students will develop the skills for systematic discovery to understand the science of the natural world around them in greater depth by using scientific inquiry. The threads that will be woven throughout the second grade curriculum include living and nonliving things may move, a moving object has energy, air moving is wind and wind can make a windmill turn, changes in energy and movement can cause change to organisms and the environments in which they live.

Area of Science: Earth and Space
The Atmosphere

In this unit students will learn:

1. Air has properties that can be observed and measured.
2. The transfer of energy in the atmosphere causes air movement, which is felt as wind.
3. Wind speed and direction can be measured.
4. Water is present in the atmosphere as water vapor.
5. When water vapor in the atmosphere cools it forms clouds, fog, rain, ice, snow, sleet or hail.
6. Changes in energy affect all aspects of weather, including temperature, precipitation, and wind.

Standards

- The atmosphere is primarily made up of air.
- Water is present in the atmosphere.
- Long-term and short-term weather changes occur due to changes in energy.

Area of Science: Physical Science
Changes in Motion

In this unit students will learn:

1. Motion can increase, change direction, or stop depending on the force applied.
2. The change in motion of an object is related to the size of the force.
3. Some forces act without touching, such as using a magnet to move an object or objects falling to the ground.

Standards

- Forces change the motion of an object.

Area of Science: Life Science
Interactions with Habitats

In this unit students will learn:

1. Living things function and interact with their physical environments.
2. Living things cause changes in the environments where they live.

3. Changes can be fast or slow.
4. Some kinds of organisms become extinct when their basic needs are no longer met or the environment changes.

Standards

- Living things cause changes on Earth.
- All organisms alive today result from their ancestors, some of which may be extinct. Not all kinds of organisms that lived in the past are represented by living organisms today.

Third Grade Science

Students will study units with an overall theme of how things are interconnected and work as systems. Matter is what makes up all living and nonliving substances on Earth. Matter has specific properties and exists in different states. Earth's resources are made of matter. Matter can be used by living things for materials and energy. There are many different forms of energy. Each living component of an ecosystem is composed of matter and uses energy. Additionally, living things resemble their parents, have life cycles, and adapt to survive in their natural environments.

Area of Science: Earth and Space
Earth's Resources

In this unit students will learn:

1. Soil is composed of pieces of rock, organic material, water and air.
2. Soil, rock and organic material have characteristics that can be measured and observed.
3. Rocks have specific characteristics that allow them to be sorted and compared.
4. Rocks form in different ways.
5. Air and water are present within rocks and soil and are important in the formation of rocks and soil.
6. Air and water are nonliving resources.
7. Renewable energy resources such as wind, water or solar energy can be replenished within a short amount of time by natural processes.
8. Nonrenewable energy is a finite resource such as natural gas, coal or oil, which cannot be replenished in a short amount of time.
9. Conserving energy through reduction of use and decreasing waste is important because some of Earth's resources are limited.

Standards

- Earth's nonliving resources have specific properties.
- Earth's resources can be used for energy.
- Some of Earth's resources are limited.

Area of Science: Physical Science
Matter and Forms of Energy

In this unit students will learn:

1. Matter takes up space and has mass. (Differentiating between mass and weight is NOT necessary at this grade level.)
2. Objects are composed of matter.
3. Matter exists in states and has observable properties.
4. Matter is anything that has mass and takes up space.
5. The most recognizable states of matter are solid, liquid and gasses.
6. Shapes and compressibility are properties that can distinguish between the states of matter.
7. One way to change matter from one state to another is by heating or cooling.
8. There are many different forms of energy. Energy is the ability to cause motion or

create change.

Standards

- All objects and substances in the natural world are composed of matter.
- Matter exists in different states, each of which has different properties.
- Heat, electrical energy, light, sound, and magnetic energy are forms of energy.

Area of Science: Life Science
Behavior, Growth and Changes

In this unit students will learn:

1. Individual organisms inherit physical and behavioral traits from their parents.
2. Some behavioral traits are learned through interactions with the environment and are not inherited.
3. Plants and animals have physical features that are associated with the environments where they live.
4. Plants and animals have certain physical or behavioral characteristics that influence their chances of surviving in particular environments.
5. Worldwide, organisms are growing, reproducing, dying and decaying.
6. The details of the life cycle are different for different organisms, which affects their ability to survive and reproduce in their natural environments.

Standards

- Offspring resemble their parents and each other.
- Individuals of the same kind of organism differ in their inherited traits. These differences give some individuals an advantage in surviving and/or reproducing.
- Plants and animals have life cycles that are part of their adaptations for survival in their natural environments.

Fourth Grade Science

Students will develop an understanding of three main areas of focus. The first area of focus is the Earth's Surface. This area includes landforms, weathering, erosion, and deposition. The second area of focus is electricity, heat, and matter. This area includes states of matter, types of energy, energy transformations and energy transfers. The third area of focus is Earth's living history. This area includes ecosystems, biodiversity, and fossils.

Area of Science: Earth and Space
Earth's Surface

In this unit students will learn:

1. About 70 percent of the Earth's surface is covered with water and most of that is the ocean. Only a small portion of the Earth's water is freshwater, which is found in rivers, lakes, groundwater and glaciers.
2. Earth's surface can change due to erosion and deposition of soil, rock or sediment.
3. Catastrophic events such as flooding, volcanoes and earthquakes can create landforms.
4. To recognize common landforms.
5. Rocks change shape, size and/or form due to water or glacial movement, freeze and thaw, wind, plant growth, acid rain, pollution and catastrophic events such as earthquakes, flooding, and volcanic activity.
6. Gravitational force affects movements of water, rock and soil.

Standards

- Earth's surface has specific characteristics and landforms that can be identified.
- The surface of Earth changes due to weathering.
- The surface of Earth changes due to erosion and deposition.

Area of Science: Physical Science
Electricity, Heat and Matter

In this unit students will learn:

1. When an object is broken into smaller pieces, when a solid is dissolved in a liquid, or when matter changes state (solid, liquid, gas), the total amount of matter remains constant.
2. Energy transfers from hot objects to cold objects as heat, resulting in a temperature change.
3. Electric circuits require a complete loop of conducting materials through which electrical energy can be transferred.
4. Electrical energy in circuits can be transformed to other forms of energy, including light, heat, sound and motion.
5. Electricity and magnetism are closely related.

Standards

- When objects break into smaller pieces, dissolve, or change state, the total amount of matter is conserved.
- Energy can be transferred from one location to another or can be transformed from one form to another.

Area of Science: Life Science
Earth's Living History

In this unit students will learn:

1. Ecosystems can change gradually or dramatically. When the environment changes, some plants and animals survive and reproduce and others die or move to new locations.
2. Ecosystems are based on interrelationships among and between biotic and abiotic factors. These include the diversity of other organisms present, the availability of food and other resources, and the physical attributes of the environment.
3. The concept of biodiversity is expanded to include different classification schemes based upon shared internal and external characteristics of organisms.
4. Most species that have lived on Earth are extinct.
5. Fossils provide a point of comparison between the types of organisms that lived long ago and those existing today.

Standards

- Changes in an organism's environment are sometimes beneficial to its survival and sometimes harmful.
- Fossils can be compared to one another and to present-day organisms according to their similarities and differences.

Fifth Grade Science

Students will learn that cycles of Earth, such as those occurring in ecosystems, in the solar system, and in the movement of light and sound result in describable patterns. Students will also learn that speed is a measurement of movement and change is related to force and mass. Finally, they will learn about the transfer of energy that drives changes in systems, including ecosystems and physical systems.

Area of Science: Life Science
Interactions with Ecosystems

In this unit students will learn:

1. Populations of organisms can be categorized by how they acquire energy.
2. Food webs can be used to identify the relationships among producers, consumers, and decomposers in an ecosystem.
3. For ecosystems the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred and transformed by producers into energy that organisms use through the process of photosynthesis. That energy is used or stored by the producer and can be passed from organism to organism as illustrated in food webs.
4. There are predator-prey and symbiotic relationships between organisms.
5. Investigations of locally threatened or endangered species can be conducted and include considerations of the effects of remediation programs, species loss, and the introduction of new species on the local ecosystem.

Standards

- Organisms perform a variety of roles in the ecosystem.
- All the processes that take place within organisms require energy.

Area of Science: Physical Science
Light, Sound and Motion

In this unit students will learn:

<u>Force and Motion</u>

1. The motion of an object can change by speeding up, slowing down, or changing direction. Force and direction are responsible for these changes.
2. Movement can be measured by speed. The speed of an object is calculated by determining the distance (d) traveled in a period of time (t).
3. Mass and force each have different effects on motion.
4. Any change in speed or direction of an object requires a force and is affected by the mass of the object and the amount of force applied.
5. Balanced and unbalanced forces cause changes in motion.

<u>Light and Sound</u>

6. Light travels and maintains its direction until it interacts with an object or moves from one medium to another and then it can be reflected, refracted, absorbed, or passes through (transparent, translucent, opaque).
7. Temperature increases depending on absorption, material of the object, intensity of and

angle at which light strikes, and how long the light shines on the object.
8. Sound is produced by vibrating objects and requires a medium through which to travel at different speeds. The rate of vibration is related to the pitch of the sound.
9. Sound can be absorbed, reflected, continued through, or a combination of these possibilities.
10. Light travels faster than sound.

Standards

- The amount of change in the movement of an object is based on the mass of the object and the amount of force exerted.
- Light and sound are forms of energy that behave in predictable ways.

Area of Science: Earth and Space
Cycles and Patterns in the Solar System

In this unit students will learn:

1. Each planet in the solar system has unique characteristics.
2. Gravitational forces and orbital paths between the sun, planets, moons and other objects in our solar system.
3. The distance from the sun, size, composition, and movement of each planet are unique.
4. The sun is the closest star to Earth and the only star in our solar system.
5. Earth's revolution around the sun (in an elliptical orbit) along with its tilt (23.5° angle) affects the direct sunlight and therefore average daily temperatures.
6. Earth takes 365 days to complete one revolution around the sun and a 24 hour period to rotate on its axis. This also makes the sun, stars, and moon appear to change position in the sky.
7. Moons, comets, asteroids, meteors, dwarf planets: composition, orbital pattern, and how they move around the sun.
8. Tools and technology of astronomers is an essential part of understanding the workings within the solar system.

Standards

- The solar system includes the sun and all celestial bodies that orbit the sun. Each planet in the solar system has unique characteristics.
- The sun is one of the many stars that exists in the universe.
- Most of the cycles and patterns of motion between the Earth and sun are predictable.

Sixth Grade Science

Students will focus on the study of rocks, minerals, and soil which make up the lithosphere. They will classify and identify different types of rocks, minerals, soil, and decode their past environment. Students will learn that all matter is made of small particles called atoms. The students will understand the properties of matter are based on the order and organization of atoms and molecules. Students will understand that cells, minerals, rocks, and soil are all examples of matter. Students will investigate linear motion and kinetic and potential energy. They will learn that all organisms are composed of cells, which are the fundamental unit of life. Students will learn cells carry on the many processes that sustain life, and all cells come from pre-existing cells.

Area of Science: Earth and Space
Rocks, Minerals and Soil

In this unit students will learn:

1. Rocks are composed of one or more minerals.
2. Mineral composition can help identify rocks.
3. The properties of minerals help us identify them and indicate the type of environment in which they were formed.
4. Soil formation occurs at different rates and has different measurable properties depending on environmental conditions.
5. Uses of rocks, minerals, and soil depend on their properties.
6. Since rocks, minerals, and soil are non-renewable resources, there should be an effort to manage them.

Standards

- Minerals have specific, quantifiable properties.
- Igneous, metamorphic and sedimentary rocks have unique characteristics that can be used for identification and/or classification.
- Igneous, metamorphic and sedimentary rocks form in different ways.
- Soil is an unconsolidated material that contains nutrient matter and weathered rock.
- Rocks, minerals and soils have common and practical uses.

Area of Science: Physical Science
Matter and Motion

In this unit students will learn:

1. Matter is made of atoms.
2. All matter has measurable properties such as mass and volume.
3. Density can be used to identify a material.
4. An element is a chemical substance that cannot be broken down into simpler substances. All atoms of any one element are alike.
5. Molecules are the combination of two or more atoms that are joined together chemically.
6. Thermal energy is the total amount of kinetic energy.

7. Thermal energy and temperature are not the same.
8. Particles are not created or destroyed during a phase change. Increasing/decreasing particle motion can cause a phase change.
9. There are two types of energy, kinetic and potential.
10. Total amount of energy remains constant; energy transforms and is not created or destroyed.
11. There are several different forms of energy; sound, light, microwave, thermal.
12. Speed can be calculated by dividing distance traveled by the elapsed time and can be graphed.

Standards

- Matter is made up of small particles called atoms.
- Changes of state are explained by a model of matter composed of particles that are in motion.
- There are two categories of energy: kinetic and potential
- An object's motion can be described by its speed and the direction in which it is moving.

Area of Science: Life Science
Cellular to Multicellular

In this unit students will learn:

1. All living things are composed of cells.
2. Cells come from pre-existing cells.
3. Cells repeatedly divide resulting in more cells and growth and repair in multicellular organisms.
4. Cells have particular structures that are related to their functions which are regulated and controlled.
5. Chromosomes are the structures in cells that contain genetic material.
6. The level of organization within organisms includes cells, tissues, organs, organ systems, and whole organisms.
7. Organisms have diverse body plans, symmetry, and internal structures that contribute to their survival in the environment.

Standards

- Cells are the fundamental unit of life.
- All cells come from preexisting cells.
- Cells carry on specific functions that sustain life.
- Living systems at all levels of organization demonstrate the complementary nature of structure and function.

Seventh Grade Science

Overall, students will focus on the study of matter and energy as they move throughout Earth's systems. Systems can exchange energy and/or matter when interactions occur within systems and between systems. Systems cycle matter and energy in observable and predictable patterns. Specifically, students will learn about Earth's hydrologic cycle, patterns that exist in atmospheric and oceanic currents, the relationship between thermal energy and the currents, and the relative position and movement of the Earth, sun and moon. Students will learn about the arrangements of atoms on the Periodic Table of Elements, conservation of mass and energy, transformation and transfer of energy. Lastly, students will focus on the impact of matter and energy transfer within the biotic component of ecosystems.

Energy Unit

In this unit students will learn:

1. When energy is transferred from one system to another, the quantity of energy before transfer equals the quantity of energy after transfer.
2. When energy is transformed from one form to another, the total amount of energy remains the same.
3. Mechanical energy can be transferred when objects push or pull on each other over a distance.
4. Mechanical waves must travel through a medium.
5. Electromagnetic waves transfer energy when they interact with matter.
6. Thermal energy can be transferred through radiation, convection and conduction.
7. Electrical energy transfers when an electrical source is connected in a complete electrical circuit to an electrical device.
8. Waves can be described by their speed, wavelength, amplitude and frequency.

Standards

- Energy can be transformed or transferred but is never lost.
- Energy can be transferred through a variety of ways.

Atmosphere and Water

In this unit students will learn:

1. As water changes state and energy is transferred, it cycles from one sphere into another (e.g., water transfers from the hydrosphere to the atmosphere when evaporation occurs).
2. Groundwater and surface water quality are components of the hydrologic cycle (porosity and permeability impact these due to water flow rate).
3. Contamination can occur within any step of the hydrologic cycle.
4. There are defined layers of the atmosphere that have specific properties (temperature, chemical composition and physical characteristics
5. Gasses in the atmosphere include nitrogen, oxygen, water vapor, carbon dioxide and other trace gasses.

6. Atmospheric cycles illustrate the movement of specific elements or molecules (such as carbon or nitrogen) through Earth's spheres.

Standards

- The hydrologic cycle illustrates the changing states of water as it moves through the lithosphere, biosphere, hydrosphere, and atmosphere.
- The atmosphere has different properties at different elevations and contains a mixture of gasses that cycles through the lithosphere, biosphere, hydrosphere, and atmosphere.

Currents and Climate

In this unit students will learn:

1. As thermal energy transfers occur in the atmosphere and ocean, currents form.
2. Ocean currents (and other large bodies of water) influence global climate patterns on Earth.
3. Other factors such as density, salinity, ocean floor topography, and Earth's rotation influence ocean currents.

Standards

- Thermal energy transfers in the ocean and atmosphere contribute to the formation of currents, which influence global climate patterns.

Biomes and Ecosystems

In this unit students will learn:

1. Biomes are defined by the abiotic (nonliving) components of the environment.
2. Ecosystems change (the number and types of species) over time due to the abiotic and biotic components of an ecosystem.
3. Climate zones determine biomes along with other abiotic factors (temperature, precipitation, soil types, solar radiation).
4. Energy and matter within an ecosystem is continually undergoing changes in form and location; as long as it stays within that ecosystem the total amount of energy will stay the same.
5. Some energy is stored while the rest is used or transferred to the ecosystem.
6. Plants use the energy in light to make sugars out of carbon dioxide and water (photosynthesis). These materials can be used and immediately stored for later use.
7. Organisms that eat plants break down plant structures to convert the materials into energy they need to survive. Then they are consumed by other organisms.
8. Energy can transform from one form to another in living things.

Standards
● Energy flows and matter is transferred continuously from one organism to another and between organisms and their physical environments. ● In any particular biome, the number, growth and survival of organisms and populations depend on biotic and abiotic factors.

Chemistry
In this unit students will learn: ● Substances are classified as a metal, nonmetal, or metalloid and can be organized by similar properties (color, solubility, density, conductivity, melting and boiling point, malleability). ● Elements with similar properties are grouped together on the periodic table. ● In a closed system, the number and types of atoms stay the same so the mass remains constant. ● Matter cannot be created or destroyed, it can only change form.
Standards
● Elements can be organized by properties. ● Matter can be separated or changed, but in a closed system, the number and types of atoms remains constant.

Earth, Moon and Sun
In this unit students will learn: 1. The Moon's orbit and its change of position relative to the Earth and Sun result in different parts of the moon being visible from Earth (phases of the Moon). 2. A solar eclipse is when Earth moves into the shadow of the Moon (during a new Moon phase). 3. A lunar eclipse is when the Moon moves into the shadow of Earth (during a full Moon phase). 4. Gravitational force between the Earth and the Moon causes daily oceanic tides. 5. Earth's tilt and revolution around the Sun affect the direct sunlight that the Earth receives in a single day throughout the year.
Standards
● The relative patterns of motion and positions of Earth, Moon, and Sun cause solar and lunar eclipses, tides, and phases of the Moon. ● The relative positions of Earth, Moon and the Sun cause patterns we call seasons.

Eighth Grade Science

Students will focus on three strands of Science this year: Earth Science, Physical Science, and Life Science. In Earth science, we will closely study the combinations of constructive and destructive processes that formed the Earth's surface and Earth's lithosphere consists of major and minor tectonic plates that move relative to each other. In Physical Science, evidence of the dynamic changes of Earth's surface through time is found in the geologic record. Students will also learn the composition and properties of Earth's interior are identified by the behavior of seismic waves. Students will learn that forces can act to change the motion of objects. In Life Science, students will understand that objects can experience a force due to magnetic, electrostatic, and gravitational fields. Lastly, students will learn about the diversity of species that occurs through generations. They will understand that every organism alive today comes from a long line of ancestors who reproduced successfully every generation. Students will also understand that traits are passed from parent to offspring.

Weathering, Erosion, & Deposition

In this unit students will learn:

1. Plate tectonics and other geologic processes formed Earth, which can be studied by a variety of maps such as topographic, physical, and aerial maps.
2. Tectonic activity, erosion, and deposition (major geologic processes) shape the surface of the Earth forming distinguishing features.
3. A variety of factors influence the patterns and features associated with streams and floodplains, glaciers, tectonic activity, coastlines, flooding, and deserts.

Standards

- *8.ESS.3*: A combination of constructive and destructive geologic processes formed Earth's surface.

Interior of the Earth

In this unit students will learn:

1. Earth, which was formed 4.6 billion years ago, is differentiated into distinct chemical (crust, mantle, core) and physical (upper lithosphere, lower lithosphere, asthenosphere, mesosphere, outer core, inner core) layers due to differing densities, physical, and chemical properties.
2. Thermal energy in the core (from decaying atoms, impacts during formation, friction as materials move within earth) drives convection currents.
3. Different materials refract and reflect seismic waves, providing clues as to the types of materials inside the earth.

Standards

- ESS-1: The composition and properties of Earth's interior are identified by the behavior of seismic waves

Plate Tectonics

In this unit students will learn:

1. The modern Theory of Plate Tectonics is supported with evidence from fossil distribution, paleomagnetism, seafloor spreading, paleoclimate data, continental drift, and the continental “puzzle-like-fit.”
2. The earth is split into large lithospheric plates that move due to convection currents in the asthenosphere.
3. The large lithospheric plates form boundaries between them (transform, divergent, convergent) that result in specific motion, events, or features.

Standards

- ESS-2: Earth’s lithosphere consists of major and minor tectonic plates that move relative to each other

Geologic Record

In this unit students will learn:

1. Earth has a long history that is studied using observations of the geologic record and the understanding that processes that shape the earth today are similar to those in the past (uniformitarianism).
2. There are different strategies to determine the relative age (index fossils, superposition, cross-cutting relationships) of rock and the absolute (radiometric dating) age of rock.
3. The fossil and geologic record and ice cores provide evidence of specific environments and climate conditions in Earth’s past which can be compared to those conditions today.
4. Fossils provide important evidence of how life (variation in a species) and environmental conditions have changed.

Standards

- ESS-4: Evidence of the dynamic changes of Earth’s surface through time is found in the geologic record
- LS-1: Diversity of species, a result of variation of traits, occurs through the process of evolution and extinction over many generations. The fossil record provides evidence that changes have occurred in number and types of species.

Motion & Forces

In this unit students will learn:

1. Magnetic, electrical, and gravitational forces can act at a distance over a field without touching another object, causing the object to move (push or pull).
2. The strength of the gravitational field is determined by the mass of the objects and the distance between them - less distance and more mass will increase the gravitational pull.
3. An electric field exists around objects with a net charge. Objects with the same charge will repel (push) while objects with opposite charges will attract (pull).
4. Magnetic fields exist around magnetic objects and the field lines can be seen using iron filings sprinkled around the magnet. The like poles will repel while the opposite poles

will attract.
5. The motion of an object is always measured with respect to a reference point, which can change in each situation
6. Multiple forces can be working on an object which influences the object's motion (speed and direction). The net force on an object is the sum of all forces acting on the object
7. If there is a nonzero net force (unbalanced) acting on an object, its speed and/or direction will change. If the net force is zero (balanced) the object's motion will not change. (if it was at rest, it would stay at rest; if it was in motion it would stay in motion at the same speed and direction)
8. Friction is a force that acts in a direction opposite the relative motion of objects
9. Forces acting on an object can be modeled in a force diagram. Arrows represent the forces and show the direction and strength of the force

Standards

- PS-1: Objects can experience a force due to an external field such as magnetic, electrostatic , or gravitational fields
- PS-2: Forces can act to change the motion of objects

Species & Reproduction

In this unit students will learn:

1. Reproduction is the transfer of genetic information from one generation to the next through asexual reproduction; sexual reproduction, or some organisms are capable of both.
2. Sexual reproduction occurs with the mixing of genes from two individuals. Meiosis is the cell division process that creates gametes (egg and sperm) that contain half of the genetic material necessary for survival. Upon fertilization, the new organism has a full set of DNA and they are different from the parents and may have traits that increase or decrease their chances for survival.
3. Asexual reproduction occurs with the transfer of genes from one individual to the next generation. There is no genetic variation between parents and offspring. Mitotic cell divisions create identical cells.
4. Traits are determined by instructions in DNA, which forms genes. Genes can come in different forms called alleles.
5. Gregor Mendel provided the theoretical basis for future study of modern genetics through studying pea plants. He discovered the Law of Segregation and the Law of Independent Assortment.
6. The genotype (allele combination) of the organism determines the phenotype.
7. Expression of all traits is determined by genes and environmental factors to varying degrees. Genes can be dominant or recessive (complete dominance); traits can also be codominant (genes are both dominant).
8. Variations that exist in organisms can accumulate over many generations, so organisms can be very different in appearance and behavior from their distant ancestors. These variations may allow for survival of individuals when the environment changes. If the environment changes and the individual organism of that species does not have the traits necessary to survive and reproduce in the changed environment the species will go extinct.
9. The environment determines how beneficial a trait will be for the survival and

reproductive success of an organism or an entire species.
Standards
• LS-1: Diversity of species, a result of variation of traits, occurs through the process of evolution and extinction over many generations. The fossil record provides evidence that changes have occurred in number and types of species. • LS-2: Every organism alive today comes from a long line of ancestors who reproduced successfully every generation • LS-3: The characteristics of an organism are a result of inherited traits received from parent(s)

High School Science

Biology

This course is a survey course in biology for freshmen. Students will focus on several areas of biology including the cell and its functions, biochemistry, genetics, ecology, weather and current events in biology. In addition to class readings and discussions, students will participate in a variety of labs and other hands-on activities in order to gain knowledge of these subject areas.

Cells

In this unit students will learn:

Building on knowledge from middle school (cell theory, cell division and differentiation), this topic focuses on the cell as a system itself (single-celled organism) and as part of larger systems (multicellular organism), sometimes as part of a multicellular organism, always as part of an ecosystem. The cell is a system that conducts a variety of functions associated with life. Details of cellular processes such as photosynthesis, chemosynthesis, cellular respiration and biosynthesis of macromolecules are addressed at this grade level. The concept of the cell and its parts as a functioning biochemical system is more important than just memorizing the parts of the cell.

Standards

- B.C: CELLS
- B.C.1: Cell structure and function
  - Structure, function and interrelatedness of cell organelles
  - Eukaryotic cells and prokaryotic cells
- B.C.2: Cellular processes
  - Characteristics of life regulated by cellular processes
  - Photosynthesis, chemosynthesis, cellular respiration, biosynthesis of macromolecules

Heredity

In this unit students will learn:

1. Building on knowledge from elementary school (plants and animals have life cycles and offspring resemble their parents) and knowledge from middle school (reproduction, Mendelian genetics, inherited traits and diversity of species)
2. Heredity focuses on the explanation of genetic patterns of inheritance. In middle school, students learn that living things are a result of one or two parents, and traits are passed to the next generation through either asexual or sexual reproduction.
3. Foundational concepts of mitosis and meiosis are introduced in grades 6 and 8. In addition, they learned that traits are defined by instructions encoded in many discrete genes and that a gene may come in more than one form called alleles

- B.H: HEREDITY
- B.H.1: Cellular genetics
- B.H.2: Structure and function of DNA in cells
- B.H.3: Genetic mechanisms and inheritance
- B.H.4: Mutations
- B.H.5: Modern genetics

Evolution

In this unit students will learn:

The basic concept of biological evolution is that Earth's present-day species descended from earlier, common ancestral species. At the elementary school level, evolution concepts include the relationship between organisms and the environment, interactions among parents and offspring and an introduction to the fossil record and extinction. At the middle school level, concepts include biodiversity (as part of biomes) and speciation, further exploration of the fossil record and Earth's history, changing environmental conditions (abiotic factors), natural selection and biological evolution. At the high school level, the study of evolution includes Modern Synthesis, the unification of genetics and evolution, historical perspectives of evolutionary theory, gene flow, mutation, speciation, natural selection, genetic drift and sexual selection.

Standards

- B.E: EVOLUTION
- B.E.1: Mechanisms
  - Natural selection
  - Mutation
  - Genetic drift
  - Gene flow (immigration, emigration)
  - Sexual selection
- B.E.2: Speciation
  - Biological classification expanded to molecular evidence
  - Variation of organisms within a species due to population genetics and gene frequency

Biodiversity and Interdependence of Life

In this unit students will learn:

Building on knowledge from elementary school (interactions of organisms within their environment and the law of conservation of matter and energy, food webs) and from middle school (flow of energy through organisms, biomes and biogeochemical cycles), this topic at the high school level focuses on the study of diversity and similarity at the molecular level of organisms. Additionally, the effects of physical/chemical constraints on all biological relationships and systems are investigated. The unidirectional flow of energy and the cycling of matter as organisms grow, reproduce and die occurs at all

levels of biological organization. Previous knowledge focused on biological systems at equilibrium; at the high school level, biological systems not at equilibrium and their responses are considered. Diagrams and models are used to explain the effects of real-world interactions and events within an ecosystem.

Standards

- B.DI: DIVERSITY AND INTERDEPENDENCE OF LIFE
- B.DI.1: Biodiversity
    - Genetic diversity
    - Species diversity
- B.DI.2: Ecosystems
    - Equilibrium and disequilibrium
    - Carrying capacity
- B.DI.3: Loss of Diversity
    - Climate change
    - Anthropocene effects
    - Extinction
    - Invasive species

AP Biology

AP Biology is equivalent to an introductory collegiate general biology course and is designed for those students who have a strong interest in the life sciences. This course includes advanced instruction of topics covered in Biology such as basic chemistry, cellular structure and function, genetics, evolution, ecology and classification. New topics include: organic chemistry, membrane structure and function, molecular genetics, cell communication and human biology. The goal of this course is to prepare students to take the Advanced Placement Biology Exam.

Unit 1 Chemistry of Life

In this unit students will learn:
This first unit sets the foundation for students to understand the chemical basis of life, which is needed for mastery of future areas of focus and provides students with a survey of the elements necessary for carbon-based systems to function. Students learn that water and the properties of water play a vital role in the survival of individuals and biological systems. They also learn that living systems exist in a highly complex organization that requires input of energy and the exchange of macromolecules. This unit also addresses in detail how and in what conformations molecules called monomers bond together to form polymers. The structure of monomers and polymers determines their function. In the units that follow, students will need to understand and explain the interaction and bonding of atoms to form molecules.

Standards

- Explain how the properties of water that result from its polarity and hydrogen bonding affect its biological function.
- Describe the composition of macromolecules required by living organisms.
- Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules.
- Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules.
- Explain how a change in the subunits of a polymer may lead to changes in structure or function of the macromolecule.
- Describe the structural similarities and differences between DNA and RNA.

Unit 2 Cell Structure and Function

In this unit students will learn:
The cell is the basic unit of life. Cells contribute to the organization of life and provide the environment in which organelles function. Organelles in turn provide compartmentalization and organize cellular products for dispersal and waste for disposal. Cells have membranes that allow them to establish and maintain an internal environment. These membranes also control the exchange of material with the cell's external environment—an important, foundational concept. The maintenance of the internal and external conditions of a cell is called homeostasis. Student understanding of these concepts will be necessary in later units when the focus of instruction shifts to cellular products and by-products and when students learn why cellular exchange of energy and materials matters.

Standards

- Describe the structure and/ or function of subcellular components and organelles.
- Explain how subcellular components and organelles contribute to the function of the cell
- Explain the effect of surface area-to-volume ratios on the exchange of materials between cells or organisms and the environment.
- Explain how specialized structures and strategies are used for the efficient exchange of molecules to the environment.
- Describe the roles of each of the components of the cell membrane in maintaining the internal environment of the cell.
- Describe the Fluid Mosaic Model of cell membranes.
- Explain how the structure of biological membranes influences selective permeability.
- Describe the role of the cell wall in maintaining cell structure and function.
- Describe the mechanisms that organisms use to maintain solute and water balance.
- Describe the mechanisms that organisms use to transport large molecules across the plasma membrane.
- Explain how the structure of a molecule affects its ability to pass through the plasma membrane.
- Explain how concentration gradients affect the movement of molecules across membranes.
- Explain how osmoregulatory mechanisms contribute to the health and survival of organisms.
- Describe the processes that allow ions and other molecules to move across membranes.
- Describe the membrane-bound structures of the eukaryotic cell.
- Explain how internal membranes and membrane-bound organelles contribute to compartmentalization of eukaryotic cell functions.
- Describe similarities and/or differences in compartmentalization between prokaryotic and eukaryotic cells.
- Describe the relationship between the functions of endosymbiotic organelles and their free-living ancestral counterparts.

Unit 3 Cellular Energetics

In this unit students will learn:

In Unit 3, students build on knowledge gained in Unit 2 about the structure and function of cells, focusing on cellular energetics. Living systems are complex in their organization and require constant energy input. This unit will provide students with the knowledge necessary to master the concepts of energy capture and use. Students work through enzyme structure and function, learning the ways in which the environment plays a role in how enzymes perform their function(s). Students gain a deeper understanding of the processes of photosynthesis and cellular respiration, knowledge they will use in Unit 6 while studying how cells use energy to fuel life processes.

Standards

- Describe the properties of enzymes.
- Explain how enzymes affect the rate of biological reactions.
- Explain how changes to the structure of an enzyme may affect its function.
- Explain how the cellular environment affects enzyme activity
- Describe the role of energy in living organisms.
- Describe the photosynthetic processes that allow organisms to capture and store energy.
- Explain how cells capture energy from light and transfer it to biological molecules for storage and use.
- Describe the processes that allow organisms to use energy stored in biological macromolecules.
- Explain how cells obtain energy from biological macromolecules in order to power cellular functions.
- Explain the connection between variation in the number and types of molecules within cells to the ability of the organism to survive and/or reproduce in different environments.

Unit 4 Cell Communication and Cell Cycle

In this unit students will learn:

In Unit 4, students continue to learn about the role of cells, focusing on how cells use energy and information transmission to communicate and replicate. Through systems of complex transduction pathways, cells can communicate with one another. Cells can also generate and receive signals, coordinate mechanisms for growth, and respond to environmental cues. To maintain homeostasis, cells respond to their environment. They can also replicate and regulate replication as part of the cell cycle that provides for the continuity of life. In Unit 5, students will move on to learn about heredity.

Standards

- Describe the ways that cells can communicate with one another.
- Explain how cells communicate with one another over short and long distances.
- Describe the components of a signal transduction pathway.
- Describe the role of components of a signal transduction pathway in producing a cellular response.
- Describe the role of the environment in eliciting a cellular response.
- Describe the different types of cellular responses elicited by a signal transduction pathway.
- Explain how a change in the structure of any signaling molecule affects the activity of the signaling pathway.
- Describe positive and/ or negative feedback mechanisms.
- Explain how negative feedback helps to maintain homeostasis.
- Explain how positive feedback affects homeostasis.
- Describe the events that occur in the cell cycle.
- Explain how mitosis results in the transmission of chromosomes from one generation to the next.
- Describe the role of checkpoints in regulating the cell cycle.
- Describe the effects of disruptions to the cell cycle on the cell or organism.

Unit 5 Heredity

In this unit students will learn:

Unit 5 focuses on heredity and the biological concepts and processes involved in ensuring the continuity of life. Students learn that the storage and transmission of genetic information via chromosomes from one generation to the next occur through meiosis. Meiotic division ensures genetic diversity, which is crucial to the survival of a species. In this unit, students gain a deeper understanding of Mendelian genetics and learn how non-Mendelian genetics describes those patterns of inheritance that seem to violate Mendel's laws. This unit also teaches the role played by chromosomal inheritance, environmental factors, and nondisjunction on an individual's phenotype. In Unit 6, students move on to learn about gene expression and regulation.

Standards

- Explain how meiosis results in the transmission of chromosomes from one generation to the next.
- Describe similarities and/ or differences between the phases and outcomes of mitosis and meiosis.
- Explain how the process of meiosis generates genetic diversity.
- Explain how shared, conserved, fundamental processes and features support the concept of common ancestry for all organisms.
- Explain the inheritance of genes and traits as described by Mendel's laws.
- Explain deviations from Mendel's model of the inheritance of traits
- Explain how the same genotype can result in multiple phenotypes under different environmental conditions.
- Explain how chromosomal inheritance generates genetic variation in sexual reproduction.

Unit 6 Gene Expression and Regulation

In this unit students will learn:

Progressing from the continuity of life to gene expression, in Unit 6 students gain in-depth knowledge about nucleic acids and their role in gene expression. Students receive a finer focus on the comparison between the structures of DNA and RNA. This unit highlights how an individual's genotype is physically expressed through that individual's phenotype. Understanding protein synthesis (transcription and translation) is vital to answering essential questions about gene expression. Regulation of gene expression and cell specialization are instrumental in ensuring survival within an individual and across populations. Unit 7 moves on to cover natural selection.phenotype. In Unit 6, students move on to learn about gene expression and regulation.

Standards

- Describe the structures involved in passing hereditary information from one generation to the next.
- Describe the characteristics of DNA that allow it to be used as the hereditary material.

- Describe the mechanisms by which genetic information is copied for transmission between generations.
- Describe the mechanisms by which genetic information flows from DNA to RNA to protein.
- Describe how the phenotype of an organism is determined by its genotype.
- Describe the types of interactions that regulate gene expression.
- Explain how the location of regulatory sequences relates to their function.
- Explain how the binding of transcription factors to promoter regions affects gene expression and/or the phenotype of the organism.
- Explain the connection between the regulation of gene expression and phenotypic differences in cells and organisms.
- Describe the various types of mutation.
- Explain how changes in genotype may result in changes in phenotype.
- Explain how alterations in DNA sequences contribute to variation that can be subject to natural selection.
- Explain the use of genetic engineering techniques in analyzing or manipulating DNA.

Unit 7 Evolution and Natural Selection

In this unit students will learn:

The concepts in Unit 7 build on foundational content from previous units as students discover natural selection, a mechanism of evolution—the theory that populations that are better adapted to their environment will survive and reproduce. Thus, the evolution of a species involves a change in its genetic makeup over time. In this unit, students study the evidence for and mechanisms of evolutionary change. Students also learn what happens when a species does not adapt to a changing or volatile environment and about the Hardy-Weinberg equilibrium as a model for describing and predicting allele frequencies in non evolving populations. Students will learn to calculate and draw conclusions about the evolution, or lack thereof, of a population from data related to allele frequencies. Biological principles studied here and in previous units will culminate in Unit 8, which covers ecology.

Standards

- Describe the causes of natural selection.
- Explain how natural selection affects populations.
- Describe the importance of phenotypic variation in a population.
- Explain how humans can affect diversity within a population.
- Explain the relationship between changes in the environment and evolutionary changes in the population.
- Explain how random occurrences affect the genetic makeup of a population.
- Describe the role of random processes in the evolution of specific populations.
- Describe the change in the genetic makeup of a population over time.
- Describe the conditions under which allele and genotype frequencies will change in populations.
- Explain the impacts on the population if any of the conditions of HardyWeinberg are not met.
- Describe the types of data that provide evidence for evolution.
- Explain how morphological, biochemical, and geological data provide evidence that

organisms have changed over time.
- Describe the fundamental molecular and cellular features shared across all domains of life, which provide evidence of common ancestry
- Describe structural and functional evidence on cellular and molecular levels that provides evidence for the common ancestry of all eukaryotes.
- Explain how evolution is an ongoing process in all living organisms.
- Describe the types of evidence that can be used to infer an evolutionary relationship.
- Explain how a phylogenetic tree and/or cladogram can be used to infer evolutionary relatedness.
- Describe the conditions under which new species may arise.
- Describe the rate of evolution and speciation under different ecological conditions.
- Explain the processes and mechanisms that drive speciation.
- Describe factors that lead to the extinction of a population.
- Explain how the risk of extinction is affected by changes in the environment.
- Explain species diversity in an ecosystem as a function of speciation and extinction rates.
- Explain how extinction can make new environments available for adaptive radiation.
- Explain how the genetic diversity of a species or population affects its ability to withstand environmental pressures.
- Describe the scientific evidence that provides support for models of the origin of life on Earth.

Unit 8 Ecology

In this unit students will learn:

As a culmination of this course, Unit 8 brings together all other units to show how a system's interactions are directly related to the system's available energy and its ability to evolve and respond to changes in its environment. When highly complex living systems interact, communities and ecosystems will change based on those interactions. The more biodiversity present in a system, the more likely that system is to maintain its health and success in the face of disruption. Energy flows through systems; the rate of flow determines the success of the species within the systems. By this point in the curriculum, a student should be able to accurately determine what happens within biological systems when disruptions occur.

Standards

- Explain how the behavioral and/or physiological response of an organism is related to changes in internal or external environment.
- Explain how the behavioral responses of organisms affect their overall fitness and may contribute to the success of the population.
- Describe the strategies organisms use to acquire and use energy
- Explain how changes in energy availability affect populations and ecosystems.
- Explain how the activities of autotrophs and heterotrophs enable the flow of energy within an ecosystem.
- Describe factors that influence growth dynamics of populations.
- Explain how the density of a population affects and is determined by resource availability in the environment.
- Describe the structure of a community according to its species composition and

diversity
- Explain how interactions within and among populations influence community structure.
- Explain how community structure is related to energy availability in the environment.
- Describe the relationship between ecosystem diversity and its resilience to changes in the environment.
- Explain how the addition or removal of any component of an ecosystem will affect its overall short-term and long-term structure.
- Explain the interaction between the environment and random or preexisting variations in populations.
- Explain how invasive species affect ecosystem dynamics.
- Describe human activities that lead to changes in ecosystem structure and/ or dynamics.
- Explain how geological and meteorological activity leads to changes in ecosystem structure and/or dynamics.

Chemistry

Chemistry is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires a three-unit course with inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.The study of matter through the exploration of classification, its structure and its interactions is how this course is organized. Investigations are used to understand and explain the behavior of matter in a variety of inquiry and design scenarios that incorporate scientific reasoning, analysis, communication skills and real-world applications. An understanding of leading theories and how they have informed current knowledge prepares students with higher order cognitive capabilities of evaluation, prediction and application.

C.PM.1: Atomic structure

In this unit students will learn:

Physical Science included properties and locations of protons, neutrons and electrons, atomic number, mass number, cations and anions, isotopes and the strong nuclear force which holds the nucleus together. In this course, the historical development of the atomic model and the positions of electrons are explored in greater detail.

Standards

- Evolution of atomic models/theory
- Electrons
- Electron configurations

C.PM.2: Periodic Table

In this unit students will learn:

In the Physical Science course, the concept that elements are placed in order of increasing atomic number in the periodic table such that elements with similar properties are placed in the same column is introduced. How the periodic table is divided into groups, families, periods, metals, nonmetals and metalloids is also included and will be revisited here. In this course, with more information about the electron configuration of elements, similarities in the configuration of the valence electrons for a particular group can be observed.

Standards

- Properties
- Trends

C.PM.3: Chemical bonding

In this unit students will learn:

Content in the Physical Science course included recognizing that atoms with unpaired

electrons tend to form ionic and covalent bonds with other atoms, forming molecules, ionic lattices or network covalent structures. In this course, electron configuration, electronegativity values and energy considerations will be applied to bonding and the properties of materials with different types of bonding.

Standards

- Ionic
- Polar/covalent

C.PM.4: Representing compounds

In this unit students will learn:

Using the periodic table, formulas of ionic compounds containing specific elements can be predicted. This can include ionic compounds made up of elements from groups 1, 2, 17, hydrogen, oxygen and polyatomic ions (given the formula and charge of the polyatomic ion). Given the formula, a compound can be named using conventional systems that include Greek prefixes and Roman numerals where appropriate.

Standards

- Formula writing
- Nomenclature
- Models and shapes (Lewis structures, ball and stick, molecular geometries)

C.PM.5: Quantifying matter

In this unit students will learn:

In earlier grades, properties of materials were quantified with measurements that were always associated with some error. In this course, scientific protocols for quantifying the properties of matter accurately and precisely are studied. Using the International System of Units (SI), significant digits or figures, scientific notation, error analysis and dimensional analysis are vital to scientific communication.

Standards

- Dimensional analysis
- Percent error
- Moles

C.PM.6: Intermolecular forces of attraction

In this unit students will learn:

In middle school, solids, liquids and gases were explored in relation to the spacing of the particles, motion of the particles and strength of attraction between the particles that make up the substance. The intermolecular forces of attraction between particles

that determine whether a substance is a solid, liquid or gas at room temperature are addressed in greater detail in this course.

Standards

- Types and strengths
- Implications for properties of substances
  - o Melting and boiling point
  - o Solubility
  - o Vapor pressure

C.IM.1: Chemical reactions

In this unit students will learn:

In the Physical Science course, coefficients were used to balance simple equations. Other representations, including Lewis structures and three-dimensional models, were also used and manipulated to demonstrate the conservation of matter in chemical reactions. In this course, more complex reactions will be studied, classified and represented with balanced chemical equations and three-dimensional models.

Standards

- Types of reactions
- Kinetics
- Energy
- Equilibrium
- Acids/bases

C.IM.2: Gas laws

In this unit students will learn:

The kinetic-molecular theory can be used to explain the properties of gases (pressure,temperature and volume) through the motion and interactions of its particles. Problems can also be solved involving the changes in temperature, pressure, volume and amount of a gas. When two of these four are kept constant, the relationship between the other two can be quantified, described and explained using the kinetic-molecular theory.

Standards

- Pressure, volume and temperature
- Ideal gas law

C.IM.3: Stoichiometry

In this unit students will learn:

A stoichiometric calculation involves the conversion from the amount of one substance in a chemical reaction to the amount of another substance. The coefficients of the

balanced equation indicate the ratios of the substances involved in the reaction in terms of both particles and moles. Once the number of moles of a substance is known, amounts can be changed to mass, volume of a gas, volume of solutions and/or number of particles.

Standards
• Molar calculations • Solutions • Limiting reagents

AP Chemistry

AP Chemistry is equivalent to an introductory collegiate general chemistry course and is designed to enable students to be successful on the Advanced Placement Examination in Chemistry. Students should expect extensive writing assignments and labs and more rigorous mathematical treatment of topics than in the first-year chemistry course. Many topics from the first-year chemistry course will be studied in more depth. New topics will include: reaction kinetics, electrochemistry, non-ideal equilibria, complex equilibria and thermodynamics. Students are required to attend and complete the necessary lab components of the course.

Unit 1 Atomic Structure and Properties

In this unit students will learn:

This first unit sets the foundation for the course by examining the atomic theory of matter, the fundamental premise of chemistry. Although atoms represent the foundational level of chemistry, observations of chemical properties are made on collections of atoms. Macroscopic systems involve such large numbers that they require moles as a unit of comparison. The periodic table provides information about each element's predictable periodicity as a function of the atomic number. The electronic structure of an atom can be described by an electron configuration that provides a method for describing the distribution of electrons in an atom or ion. In subsequent units, students will apply their understanding of atomic structure to models and representations of chemical phenomena and explain changes and interactions of chemical substances.

Standards

- Calculate quantities of a substance or its relative number of particles using dimensional analysis and the mole concept.
- Explain the quantitative relationship between the mass spectrum of an element and the masses of the element's isotopes.
- Explain the quantitative relationship between the elemental composition by mass and the empirical formula of a pure substance
- Explain the quantitative relationship between the elemental composition by mass and the composition of substances in a mixture.
- Represent the electron configuration of an element or ions of an element using the Aufbau principle.
- Explain the relationship between the photoelectron spectrum of an atom or ion and:
  a. The electron configuration of the species.
  b. The interactions between the electrons and the nucleus.
- Explain the relationship between trends in atomic properties of elements and electronic structure and periodicity.
- Explain the relationship between trends in the reactivity of elements and periodicity

Unit 2 Molecular and Ionic Compound Structure and Properties

In this unit students will learn:

In Unit 2, students apply their knowledge of atomic structure at the particulate level and connect it to the macroscopic properties of a substance. Both the chemical and

physical properties of materials can be explained by the structure and arrangement of atoms, ions, or molecules and the forces between them. These forces, called chemical bonds, are distinct from typical intermolecular interactions. Electronegativity can be used to make predictions about the type of bonding present between two atoms. In subsequent units, students will use the periodic table and the atomic properties to predict the type of bonding present between two atoms based on position.

Standards

- Explain the relationship between the type of bonding and the properties of the elements participating in the bond.
- Represent the relationship between potential energy and distance between atoms, based on factors that influence the interaction strength.
- Represent an ionic solid with a particulate model that is consistent with Coulomb's law and the properties of the constituent ions.
- Represent a metallic solid and/or alloy using a model to show essential characteristics of the structure and interactions present in the substance.
- Represent a molecule with a Lewis diagram.
- Represent a molecule with a Lewis diagram that accounts for resonance between equivalent structures or that uses formal charge to select between nonequivalent structures.
- Based on the relationship between Lewis diagrams, VSEPR theory, bond orders, and bond polarities:
  a. Explain structural properties of molecules.
  b. Explain electron properties of molecules.

Unit 3 Intermolecular Forces and Properties

In this unit students will learn:

Transformations of matter can be observed in ways that are generally categorized as either a chemical or physical change. The shapes of the particles involved and the space between them are key factors in determining the nature of physical changes. The properties of solids, liquids, and gases reflect the relative orderliness of the arrangement of particles in those states, their relative freedom of motion, and the nature and strength of the interactions between them. There is a relationship between the macroscopic properties of solids, liquids, and gases, as well as the structure of the constituent particles of those materials on the molecular and atomic scale. In subsequent units, students will explore chemical transformations of matter.

Standards

- Explain the relationship between the chemical structures of molecules and the relative strength of their intermolecular forces when:
  a. The molecules are of the same chemical species.
  b. The molecules are of two different chemical species.
- Explain the relationship among the macroscopic properties of a substance, the particulate-level structure of the substance, and the interactions between these particles.
- Represent the differences between solid, liquid, and gas phases using a particulate

level model.
- Explain the relationship between the macroscopic properties of a sample of gas or mixture of gases using the ideal gas law.
- Explain the relationship between the motion of particles and the macroscopic properties of gases with:
  a. The kinetic molecular theory (KMT).
  b. A particulate model. c. A graphical representation.
- Explain the relationship among non-ideal behaviors of gases, interparticle forces, and/or volumes.
- Calculate the number of solute particles, volume, or molarity of solutions.
- Using particulate models for mixtures:
  a. Represent interactions between components.
  b. Represent concentrations of components.
- Explain the relationship between the solubility of ionic and molecular compounds in aqueous and nonaqueous solvents, and the intermolecular interactions between particles.
- Explain the relationship between the solubility of ionic and molecular compounds in aqueous and nonaqueous solvents, and the intermolecular interactions between particles.
- Explain the relationship between a region of the electromagnetic spectrum and the types of molecular or electronic transitions associated with that region.
- Explain the properties of an absorbed or emitted photon in relationship to an electronic transition in an atom or molecule.
- Explain the amount of light absorbed by a solution of molecules or ions in relationship to the concentration, path length, and molar absorptivity.

Unit 4 Chemical Reactions

In this unit students will learn:

This unit explores chemical transformations of matter by building on the physical transformations studied in Unit 3. Chemical changes involve the making and breaking of chemical bonds. Many properties of a chemical system can be understood using the concepts of varying strengths of chemical bonds and weaker intermolecular interactions. When chemical changes occur, the new substances formed have properties that are distinguishable from the initial substance or substances. Chemical reactions are the primary means by which transformations in matter occur. Chemical equations are a representation of the rearrangement of atoms that occur during a chemical reaction. In subsequent units, students will explore rates at which chemical changes occur.

Standards

- Identify evidence of chemical and physical changes in matter.
- Represent changes in matter with a balanced chemical or net ionic equation:
  a. For physical changes.
  b. For given information about the identity of the reactants and/or product.
  c. For ions in a given chemical reaction.
- Represent a given chemical reaction or physical process with a consistent particulate model.

- Explain the relationship between macroscopic characteristics and bond interactions for:
  a. Chemical processes
  b. Physical processes
- Explain changes in the amounts of reactants and products based on the balanced reaction equation for a chemical process.
- Identify the equivalence point in a titration based on the amounts of the titrant and analyte, assuming the titration reaction goes to completion.
- Identify a reaction as acid-base, oxidation-reduction, or precipitation.
- Identify species as Brønsted-Lowry acids, bases, and/or conjugate acid-base pairs, based on proton-transfer involving those species.
- Represent a balanced redox reaction equation using half-reactions.

Unit 5 Kinetics

In this unit students will learn:

Unit 4 focused on chemical changes; in Unit 5 students will develop an understanding of the rates at which chemical changes occur and the factors that influence the rates. Those factors include the concentration of reactants, temperature, catalysts, and other environmental factors. Chemical changes are represented by chemical reactions, and the rates of chemical reactions are determined by the details of the molecular collisions. Rates of change in chemical reactions are observable and measurable. When measuring rates of change, students are measuring the concentration of reactant or product species as a function of time. These chemical processes may be observed in a variety of ways and often involve changes in energy as well. In subsequent units, students will describe the role of energy in changes in matter.

Standards

- Explain the relationship between the rate of a chemical reaction and experimental parameters.
- Represent experimental data with a consistent rate law expression.
- Identify the rate law expression of a chemical reaction using data that show how the concentrations of reaction species change over time.
- Represent an elementary reaction as a rate law expression using stoichiometry.
- Explain the relationship between the rate of an elementary reaction and the frequency, energy, and orientation of molecular collisions.
- Represent the activation energy and overall energy change in an elementary reaction using a reaction energy profile.
- Identify the components of a reaction mechanism.
- Identify the rate law for a reaction from a mechanism in which the first step is rate limiting.
- Identify the rate law for a reaction from a mechanism in which the first step is not rate limiting.
- Represent the activation energy and overall energy change in a multistep reaction with a reaction energy profile.
- Explain the relationship between the effect of a catalyst on a reaction and changes in the reaction mechanism.

Unit 6 Thermodynamics

In this unit students will learn:

The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter. The availability or disposition of energy plays a role in virtually all observed chemical processes. Thermodynamics provides tools for understanding this key role, particularly the conservation of energy, including energy transfer in the forms of heat and work. Chemical bonding is central to chemistry. A key concept to know is that the breaking of a chemical bond inherently requires an energy input, and because bond formation is the reverse process, it will release energy. In subsequent units, the application of thermodynamics will determine the favorability of a reaction occurring.

Standards

- Explain the relationship between experimental observations and energy changes associated with a chemical or physical transformation.
- Represent a chemical or physical transformation with an energy diagram.
- Explain the relationship between the transfer of thermal energy and molecular collisions.
- Calculate the heat q absorbed or released by a system undergoing heating/ cooling based on the amount of the substance, the heat capacity, and the change in temperature.
- Explain changes in the heat q absorbed or released by a system undergoing a phase transition based on the amount of the substance in moles and the molar enthalpy of the phase transition.
- Calculate the heat q absorbed or released by a system undergoing a chemical reaction in relationship to the amount of the reacting substance in moles and the molar enthalpy of reaction.
- Calculate the enthalpy change of a reaction based on the average bond energies of bonds broken and formed in the reaction.
- Calculate the enthalpy change for a chemical or physical process based on the standard enthalpies of formation.
- Represent a chemical or physical process as a sequence of steps.
- Explain the relationship between the enthalpy of a chemical or physical process and the sum of the enthalpies of the individual steps.

Unit 7 Equilibrium

In this unit students will learn:

Chemical equilibrium is a dynamic state in which opposing processes occur at the same rate. In this unit, students learn that any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations. A change in conditions, such as addition of a chemical species, change in temperature, or change in volume, can cause the rate of the forward and reverse reactions to fall out of balance. Le Châtelier's principle provides a means to reason qualitatively about the direction of the shift in an equilibrium system resulting from various possible stresses. The expression for the equilibrium constant, K, is a mathematical expression that describes the equilibrium

state associated with a chemical change. An analogous expression for the reaction quotient, Q, describes a chemical reaction at any point, enabling a comparison to the equilibrium state. Subsequent units will explore equilibrium constants that arise from acid-base chemistry.

Standards

- Explain the relationship between the occurrence of a reversible chemical or physical process, and the establishment of equilibrium, to experimental observations.
- Explain the relationship between the direction in which a reversible reaction proceeds and the relative rates of the forward and reverse reactions.
- Represent the reaction quotient Q_c or Q_p , for a reversible reaction, and the corresponding equilibrium expressions $K_c = Q_c$ or $K_p = Q_p$.
- Calculate K_c or K_p based on experimental observations of concentrations or pressures at equilibrium.
- Explain the relationship between very large or very small values of K and the relative concentrations of chemical species at equilibrium.
- Represent a multistep process with an overall equilibrium expression, using the constituent K expressions for each individual reaction.
- Identify the concentrations or partial pressures of chemical species at equilibrium based on the initial conditions and the equilibrium constant.
- Represent a system undergoing a reversible reaction with a particulate model.
- Identify the response of a system at equilibrium to an external stress, using Le Châtelier's principle.
- Explain the relationships between Q, K, and the direction in which a reversible reaction will proceed to reach equilibrium.
- Calculate the solubility of a salt based on the value of K_{sp} for the salt.
- Identify the solubility of a salt, and/or the value of K_{sp} for the salt, based on the concentration of a common ion already present in solution.
- Identify the qualitative effect of changes in pH on the solubility of a salt.
- Explain the relationship between the solubility of a salt and changes in the enthalpy and entropy that occur in the dissolution process.

Unit 8 Acids and Bases

In this unit students will learn:

This unit builds on the content about chemical equilibrium studied in Unit 7. Chemical equilibrium plays an important role in acid-base chemistry and solubility. The proton-exchange reactions of acid-base chemistry are reversible reactions that reach equilibrium quickly, and much of acid-base chemistry can be understood by applying the principles of chemical equilibrium. Most acid-base reactions have either large or small values of K, which means qualitative conclusions regarding equilibrium state can often be drawn without extensive computations. The dissolution of a solid in a solvent can also be understood by applying the principles of chemical equilibrium because it is a reversible reaction that often reaches equilibrium quickly. In the final unit, the equilibrium constant is related to temperature and the difference in Gibbs free energy between the reactants and products.

Standards

- Calculate the values of pH and pOH, based on K_w and the concentration of all species present in a neutral solution of water.
- Calculate pH and pOH based on concentrations of all species in a solution of a strong acid or a strong base.
- Explain the relationship among pH, pOH, and concentrations of all species in a solution of a monoprotic weak acid or weak base.
- Explain the relationship among the concentrations of major species in a mixture of weak and strong acids and bases.
- Explain results from the titration of a mono- or polyprotic acid or base solution, in relation to the properties of the solution and its components.
- Explain the relationship between the strength of an acid or base and the structure of the molecule or ion.
- Explain the relationship between the predominant form of a weak acid or base in solution at a given pH and the pK_a of the conjugate acid or the pK_b of the conjugate base.
- Explain the relationship between the ability of a buffer to stabilize pH and the reactions that occur when an acid or a base is added to a buffered solution.
- Identify the pH of a buffer solution based on the identity and concentrations of the conjugate acid-base pair used to create the buffer.
- Explain the relationship between the buffer capacity of a solution and the relative concentrations of the conjugate acid and conjugate base components of the solution.

Unit 9 Applications and Thermodynamics

In this unit students will learn:

This unit allows students to connect principles and calculations across Units 5–8. The thermodynamics of a chemical reaction is connected to both the structural aspects of the reaction and the macroscopic outcomes of the reaction. All changes in matter involve some form of energy change. One key determinant of chemical transformations is the change in potential energy that results from changes in electrostatic forces. Chemical systems undergo three main processes that change their energy: heating/cooling, phase transitions, and chemical reactions. Applying the laws of thermodynamics will allow students to describe the essential role of energy and explain and predict the direction of changes in matter.

Standards

- Identify the sign and relative magnitude of the entropy change associated with chemical or physical processes.
- Calculate the entropy change for a chemical or physical process based on the absolute entropies of the species involved in the process.
- Explain whether a physical or chemical process is thermodynamically favored based on an evaluation of ΔG^o .
- Explain, in terms of kinetics, why a thermodynamically favored reaction might not occur at a measurable rate.
- Explain whether a process is thermodynamically favored using the relationships between K, ΔG^o , and T.
- Explain the relationship between external sources of energy or coupled reactions and their ability to drive thermodynamically unfavorable processes.

- Explain the relationship between the physical components of an electrochemical cell and the overall operational principles of the cell.
- Explain whether an electrochemical cell is thermodynamically favored, based on its standard cell potential and the constituent half-reactions within the cell.
- Explain the relationship between deviations from standard cell conditions and changes in the cell potential.
- Calculate the amount of charge flow based on changes in the amounts of reactants and products in an electrochemical cell.

Earth Science

This is the third course in the series of biology, physical science and earth science. This course will explore a full range of topics in earth and environmental sciences. Earth is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires three units of science. Earth Science incorporates chemistry, physics and environmental science and introduces students to key concepts, principles and theories within geology. Investigations are used to understand and explain the behavior of nature in a variety of inquiry and design scenarios that incorporate scientific reasoning, analysis, communication skills and real-world applications.

Unit 1: What is Earth Science?

In this unit students will learn:

1. The branches of Earth Science.
2. The Spheres of the Earth
3. Maps and how to use them.

Standards

- EVN.ES.1: Properties and effects of the biosphere
- EVN.ES.2: Properties and effects of the atmosphere
- EVN.ES.3: Properties and effects of the lithosphere
- EVN.ES.4: Properties and effects of the hydrosphere
- EVN.ES.5: The interconnectedness of the spheres of the earth

Unit 2: Rocks and Minerals

In this unit students will learn:

1. The definition of and types of minerals, including their basic chemistry.
2. How to identify minerals by certain properties.
3. The three different types of rocks (igneous, sedimentary, and metamorphic), how they are made, their properties, and the rock cycle.

Standards

- PG.M: MINERALS PG.M.1: Atoms and elements
- PG.M.2: Chemical bonding (ionic, covalent, metallic)
- PG.M.3: Crystallinity (crystal structure)
- PG.M.4: Criteria of a mineral (crystalline solid, occurs in nature, inorganic, defined chemical composition)
- PG.M.5: Properties of minerals (hardness, luster, cleavage, streak, crystal shape, fluorescence, flammability, density/specific gravity, malleability)
- PG.IMS: IGNEOUS, METAMORPHIC AND SEDIMENTARY ROCKS
- PG.IMS.1: Igneous
    - Mafic and felsic rocks and minerals
    - Intrusive (igneous structures: dikes, sills, batholiths, pegmatites)
    - Earth's interior (inner core, outer core, lower mantle, upper mantle, Mohorovicic

discontinuity, crust)
    - Magnetic reversals and Earth's magnetic field
    - Thermal energy within the Earth
    - Extrusive (volcanic activity, volcanoes: cinder cones, composite, shield)
- PG.IMS.2: Metamorphic
    - Pressure, stress, temperature and compressional forces
    - Foliated (regional), non-foliated (contact)
    - Parent rock and degrees of metamorphism
    - Metamorphic zones (where metamorphic rocks are found)
- PG.IMS.3: Sedimentary
    - Division of sedimentary rocks and minerals (chemical, clastic/physical, organic)
    - Depositional environments

Unit 3: Soil and Erosion

In this unit students will learn:

1. The basics of erosion and sediment deposition.
2. The components of soil and the view of soil as a resource.

Standards

- ENV.ER.4: Soil and land
    - Desertification
    - Mass movement and erosion

Unit 4: Earthquakes and Plate Tectonics

In this unit students will learn:

1. The basic structure of the earth (layers and properties)
2. Plate tectonics and seafloor spreading
3. About earthquakes and how they occur. They will also learn about S and P waves and how to use triangulation.

Standards

- PG.PT.1: Internal Earth : Seismic waves S and P waves, velocities, reflection, refraction of waves
- PG.PT.2: Structure of Earth
    - Asthenosphere
    - Lithosphere
    - Mohorovicic boundary (Moho)
    - Composition of each of the layers of Earth
    - Gravity, magnetism and isostasy
    - Thermal energy (geothermal gradient and heat flow)
- PG.PT.3: Paleomagnetism and magnetic anomalies, Paleoclimatology
- PG.PT.4: Plate motion
    - Causes and evidence of plate motion
    - Measuring plate motion
    - Characteristics of oceanic and continental plates

- Relationship of plate movement and geologic events
- Mantle plumes

Unit 5: Volcanos

In this unit students will learn:

1. The properties of, location of, and types of volcanoes.

Standards

- ENV.ES.5: The movement of matter and energy and its effect on volcanoes
- G.PT.4: The correlations between the location of volcanoes, earthquakes, mountain, and plate tectonics

Unit 6 : Mountain Building

In this unit students will learn:

1. Types of mountain ranges
2. Parts of mountains
3. How different mountain ranges are made.

Standards

- G.PT.4: The correlations between the location of volcanoes, earthquakes, mountains, and plate tectonics

Unit 7: Weather

In this unit students will learn:

1. The atmosphere and the effect of temperature and pressure on weather.
2. The role of water in the atmosphere and how it can create different types of weather.
3. How high pressure and low pressure systems affect weather.
4. Hurricanes, tornados, and bomb cyclones.
5. Climate vs weather

Standards

EARTH SYSTEMS: INTERCONNECTED SPHERES OF EARTH

- ENV.ES.1: Biosphere
  - Evolution and adaptation in populations
  - Biodiversity
  - Ecosystems (equilibrium, species interactions, stability)
  - Population dynamics
- ENV.ES.2: Atmosphere
  - Atmospheric properties and currents
- ENV.ES.3: Lithosphere
  - Geologic events and processes

- ENV.ES.4: Hydrosphere
  - Oceanic currents and patterns (as they relate to climate)
  - Surface and groundwater flow patterns and movement
  - Cryosphere
- ENV.ES.5: Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere
  - Energy transformations on global, regional and local scales
  - Biogeochemical cycles
  - Ecosystems
  - Weather
  - Climate

Unit 8: Geologic History

In this unit students will learn:

1. The different eras in earth's history and how information about previous eras was obtained
2. How fossils and geologic phenomena are used to tell our historical story
3. How the Earth has changed over its 4.5 billion year history and why

Standards

- PG.EH.1: The geologic rock record
  - Relative and absolute age
  - Principles to determine relative age
  - Original horizontality
  - Superposition Cross-cutting relationships
  - Absolute age Radiometric dating (isotopes, radioactive decay) Correct uses of radiometric dating
  - Combining relative and absolute age data
  - The geologic time scale
  - Comprehending geologic time
  - Climate changes evident through the rock record
  - Fossil record

Unit 9: Earth's Resources

In this unit students will learn:

1. The resources of the earth (oil, water, air) and how they are made, used, and scarcity.
2. How humans rely on the earth for certain materials.
3. Renewable vs nonrenewable resources.

Standards

- PG.ER.1: Energy resources
  - Renewable and nonrenewable energy sources and efficiency
  - Alternate energy sources and efficiency
  - Resource availability

    - Mining and resource extraction
- PG.ER.2: Air
    - Primary and secondary contaminants
    - Greenhouse gases 309
- PG.ER.3: Water
    - Potable water and water quality
    - Hypoxia, eutrophication
- PG.ER.4: Soil and sediment
    - Desertification
    - Mass wasting and erosion
    - Sediment and contamination

Unit 10: The Ocean

In this unit students will learn:

1. The parts of the ocean and the ocean's behavior (tides, currents, etc.)
2. The types of ecosystems that make up the ocean
3. The properties of the ocean (temperature, pressure, density, waves)
4. The ocean and our hydrosphere as a finite resource

Standards

- PG.IMS.4: Ocean
- Tides (daily, neap and spring)
- Currents (deep and shallow, rip and longshore)
- Thermal energy and water density
- Waves
- Ocean features (ridges, trenches, island systems, abyssal zone, shelves, slopes, reefs, island arcs)
- Passive and active continental margins
- Transgressing and regressing sea levels
- Streams (channels, streambeds, floodplains, cross-bedding, alluvial fans, deltas)

Physical Science

Physical science introduces students to key concepts and theories that provide a foundation for further study in other sciences and advanced science disciplines. Physical science comprises the systematic study of the physical world as it relates to fundamental concepts about matter, energy and motion. A unified understanding of phenomena in physical, living, Earth and space systems is the culmination of all previously learned concepts related to chemistry, physics, and Earth and space science, along with historical perspective and mathematical reasoning

Unit 1: Physical Science Skills
In this unit students will learn: 1. The steps of the scientific method, to evaluate the results of experiments and draw conclusions, to design and execute controlled experiments safely, how identify known and unknown quantities from given or collected data, and to evaluate the answer and determine next steps 2. To use appropriate tools to make metric measurements, to always record scientific measurements using the metric system 3. How to select the correct type of graph to meet the needs of data, and to appropriately title and label the x and y axis
Standards
● This unit does not yet begin addressing the Ohio Physical Science standards, but addresses concepts in the Nature of Science Including: ○ Scientific Inquiry, Practice and Applications ○ Science as a Way of Knowing ○ Scientific Knowledge is Open to Revision in Light of New Evidence

Unit 2:
In this unit students will learn: 1. How to classify different types of matter 2. About the various physical and chemical properties and physical and chemical changes of matter (density, viscosity, malleability, ductility, conductivity, reactivity, flammability, toxicity…) and how these can be used to separate the components of a mixture using differences in properties as well as the indications of a chemical change 3. About the behavior of solids, liquids, and gasses based on Kinetic Theory of Matter. Students will interpret a graph to identify phase changes (boiling/condensation point, melting/freezing point) and describe the energy changes occurring in phase changes
Standards
● PS.M.1: Classification of Matter

Unit 3: Atoms and the Periodic Table

In this unit students will learn:

1. About the steps in the growth of our understanding of the atom, the key technological advances that made our understanding possible.
2. How to create models of atoms, ions, and isotopes (Bohr models and Lewis dot structures), to calculate the numbers of subatomic particles in an atom, to determine the placement on the periodic table and be able to model the atom.
3. About the families of elements and describe the basic properties of each family in order to make predictions about properties of elements that exhibit periodic trends, and to be able to identify metals, nonmetals, and metalloids by their location on the periodic table.

Standards

- PS.M.2: Atoms
- PS.M.3: Periodic Trends of Elements

Unit 4: Chemical Reactions

In this unit students will learn:

1. About Ionic, covalent, and metallic bonds, by looking at the elements they will be able to predict what type of bonding will occur between them, and describe what is occurring at the atomic level for each type of chemical bond.
2. How to name binary ionic and covalent compounds and determine the formula for binary and ternary compounds, to identify the ionic charges of atoms or groups of atoms in a molecule.
3. How to read a chemical equation and understand its parts and symbols, to identify whether a reaction is exothermic or endothermic, and to balance it if needed.

Standards

- PS.M.4: Bonding and Compounds
- PS.M.5: Reactions of Matter

Unit 5: Nuclear Reactions and Stars

In this unit students will learn:

1. the processes of fission and fusion, the cause of radioactivity, and the meaning of half life in terms of radioactive materials.
2. How lighter elements generate heavier elements through fusion in stars.
3. About the life cycle of a star from formation □ main sequence □ death, and how the Hertzsprung - Russell helps us understand evolutionary stages of stars.

Standards

- PS.M.5: Reactions of Matter
- PS.U.3: Stars

Unit 6 : Motion

In this unit students will learn:

1. How motion is relative to the observer's reference frame.
2. What instantaneous velocity is and how it changes over time.
3. How to complete calculations of Motion including, Velocity, Acceleration, Displacement, Time.
4. How to create graphs of motion data, and how to interpret Displacement vs Time and Velocity vs Time Graphs.

Standards

- PS.FM.1: Motion

Unit 7 Forces

In this unit students will learn:

1. How to interpret and construct free body diagrams to show and understand the forces acting on an object.
2. How to distinguish between action forces and reaction forces.
3. How to complete calculations of weight (Fw = mag), calculations of force (F = ma), determine net force (Fnet = F1 +F2 + F3…)

Standards

- PS.FM.2: Forces
- PS.FM.3: Dynamics

Unit 8: Energy

In this unit students will learn:

1. How to calculate Gravitational potential energy (GPE = mgh), Kinetic energy (KE = ½mv2), work (W = Fd)
2. The law of conservation of energy (KEi + GPEi = KEf + GPEf) and how is can be used to solve problems including determining relative gravitational potential energy
3. How to use work energy theorem (KE = W therefore ½mv2 = Fd) to solve real world problems

Standards

- PS.EW.1: Conservation of Energy
- PS.EW.2: Transfer and transformation of energy

Unit 9: Energy Transfers and Waves

In this unit students will learn:

1. Processes of heat transfer, including conduction, convection and radiation, Thermal conductors have a high rate of thermal energy transfer and thermal insulators have a slow rate of thermal energy transfer.
2. If the object or system absorbs more thermal energy than it emits and there is no

change in phase, the temperature increases. If the object or system emits more thermal energy than is absorbed and there is no change in phase, the temperature decreases.
3. Waves transmit energy from one place to another, can transfer energy between objects and can be described by their speed, wavelength, frequency and amplitude.
4. When a wave encounters a new material, the new material may absorb the energy of the wave by transforming it to another form of energy, usually thermal energy. (reflection, refraction, interference and diffraction).
5. Radiant energy travels in waves and does not require a medium. The electromagnetic spectrum is divided into bands that have different applications in everyday life.
6. Changes in the observed frequency and wavelength of a wave can occur if the wave source and the observer are moving relative to each other. (Doppler shift)
7. Basic properties of sound and light as it relates to vision and hearing are also covered.

Standards

- PS.EW.3: Waves
- PS.EW.4: Thermal Energy

Unit 10: Electricity

In this unit students will learn:

1. A complete loop is needed for an electrical circuit that may be in parallel or in series.
2. Electricity can be measured (current, voltage and resistance).
3. The flow of electrons then transfer energy to other objects and transform electrical energy into other forms (e.g., light, sound, heat) in the resistors.
4. To construct a variety of circuits and to measure and compare the potential difference (voltage) and current.

Standards

- PS.EW.5:Electricity

Unit 11: The Universe

In this unit students will learn:

1. The origin and evolution of our universe according to the “big bang” theory, and the supporting evidence for the expansion of the known universe (e.g., Hubble’s law, redshift, cosmic microwave, background radiation).
2. Technology provides the basis for many new discoveries related to space and the universe. (visual, radio and x-ray telescopes, computers and complicated computations; space probes; and accelerators).
3. A galaxy is a group of billions of individual stars, star systems, star clusters, dust and gas bound together by gravity. There are billions of galaxies in the universe
4. Galaxies are classified as elliptical, spiral and irregular.

Standards

- PS.U.1: History of the universe
- PS.U.2:Galaxies

Physics

This course emphasizes the techniques of problem-solving and laboratory investigation. The topics to be covered include: motion, forces, principles of work, energy and momentum, sound, light, atomic and nuclear physics, electricity and magnetism. Theoretical concepts will be related to practical applications. This course is recommended for science and math oriented students. Strong math skills are needed, especially with algebra.

1-Dimensional Motion

In this unit students will learn:

In this course, acceleration vs. time graphs are introduced and more complex graphs are considered that have both positive and negative displacement values and involve motion that occurs in stages (e.g., an object accelerates then moves with constant velocity). Symbols representing acceleration are added to motion diagrams and mathematical analysis of motion becomes increasingly more complex. Motion is explored through investigation and experimentation. Motion detectors and computer graphing applications can be used to collect and organize data. Computer simulations and video analysis can be used to analyze motion with greater precision.

Standards

- P.M.1: Motion Graphs
  - Position vs. time
  - Velocity vs. time
  - Acceleration vs. time
- P.M.2: Problem Solving
  - Using graphs (average velocity, instantaneous velocity, acceleration, displacement, change in velocity)
  - Uniform acceleration including free fall (initial velocity, final velocity, time, displacement, acceleration, average velocity)

2-Dimensional Motion

In this unit students will learn:

When an object has both horizontal and vertical components of motion, as in a projectile, the components act independently of each other. For a projectile in the absence of air resistance, this means that horizontally, the projectile will continue to travel at constant speed just like it would if there were no vertical motion. Likewise, vertically the object will accelerate just as it would without any horizontal motion. Problem solving will be limited to solving for the range, time, initial height, initial velocity or final velocity of horizontally launched projectiles with negligible air resistance. While it is not inappropriate to explore more complex projectile problems, it must not be done at the expense of other parts of the curriculum.

Standards

P.M.3: Projectile Motion

- Independence of horizontal and vertical motion

- Problem-solving involving horizontally launched projectiles

Forces

In this unit students will learn:

In this course, Newton's laws of motion are applied to mathematically describe and predict the effects of forces on more complex systems of objects and to analyze falling objects that experience significant air resistance. Gravitational forces are studied as a universal phenomenon and gravitational field strength is quantified. Elastic forces and a more detailed look at friction are included. At the atomic level, contact forces are actually due to the forces between the charged particles of the objects that appear to be touching. These electric forces are responsible for friction forces, normal forces and other contact forces. Air resistance and drag are explained using the particle nature of matter. Analysis of experimental data collected in laboratory investigations is used to study forces. This can include the use of force probes and computer software to collect and analyze data.

Standards

- P.F.1: Newton's laws applied to complex problems
- P.F.2: Gravitational force and fields
- P.F.3: Elastic Forces
- P.F.4: Friction Force (static and kinetic)
- P.F.5: Air resistance and drag
- P.F.6: Forces in two dimensions
    - Adding vector forces
    - Motion down inclines

Momentum

In this unit students will learn:

In this course, the vector properties of momentum and impulse are introduced and used to analyze elastic and inelastic collisions between objects. Analysis of experimental data collected in laboratory investigations is used to study momentum. This can include the use of force probes and computer software to collect and analyze data.

Standards

- P.F.7: Momentum, impulse and conservation of momentum

Energy

In this unit students will learn:

In this course, the concept of gravitational potential energy is understood from the

perspective of a field, elastic potential energy is introduced and quantified, nuclear processes are explored further, and the concept of mass-energy equivalence is introduced. The concept of work is expanded, power is introduced and the principle of conservation of energy is applied to increasingly complex situations. Energy is explored by analyzing data gathered in scientific investigations. Computers and probes can be used to collect and analyze data.

Standards

- P.E.1: Gravitational and potential energy
- P.E.2: Energy in springs
- P.E.3: Work and power
- P.E.4: Conservation of energy
- P.E.5: Nuclear energy

Circular Motion

In this unit students will learn:

In this course, gravitational forces are studied as a universal phenomenon and gravitational field strength is quantified. Circular motion is quantified.

Standards

- P.5.2: Gravitational force and fields
- P.F.6: Forces in two dimensions
    - Centripetal forces and circular motion

Waves

In this unit students will learn:

In this course, conservation of energy is applied to waves and the measurable properties of waves (wavelength, frequency, amplitude) are used to mathematically describe the behavior of waves (index of refraction, law of reflection, single- and double-slit diffraction). The wavelet model of wave propagation and interactions is not addressed in this course. Waves are explored experimentally in the laboratory. This may include, but is not limited to, water waves, waves in springs, the interaction of light with mirrors, lenses, barriers with one or two slits and diffraction gratings.

Standards

- P.W.1: Wave properties
    - Conservation of energy
    - Reflection
    - Refraction
    - Interference
    - Diffraction
- P.W.2: Light phenomena
    - Ray diagrams (propagation of light)
    - Law of reflection (equal angles)
    - Snell's law

- Diffraction patterns
- Wave-particle duality of light
- Visible spectrum of light

Electricity & Magnetism

In this unit students will learn:

In earlier grades, electric and magnetic potential energy were treated conceptually. The relative number of subatomic particles present in charged and neutral objects, attraction and repulsion between electrical charges and attraction and repulsion between magnetic poles were explored. The concept of fields to conceptually explain forces at a distance was introduced and the concepts of current, potential difference (voltage) and resistance were used to explain circuits. Additionally, connections between electricity and magnetism were made as observed in electromagnets, motors and generators. In this course, the details of electrical and magnetic forces and energy are further explored and can be used as additional examples of energy and forces affecting motion.

Standards

- P.EM.1: Charging objects (friction, contact, and induction)
- P.EM.2: Coulomb's law
- P.EM.3: Electric fields and electric potential energy
- P.EM.4: DC circuits
  - Ohm's law
  - Series circuits
  - Parallel circuits
  - Mixed circuits
  - Applying conservation of charge and energy (junction and loop rules)
- P.EM.5: Magnetic fields
- P.EM.6: Electromagnetic Interactions

AP Physics C: Electricity & Magnetism

AP Physics C: Electricity and Magnetism is equivalent to a second-semester college course in calculus-based physics. The course covers electrostatics, electric circuits and magnetism. Advanced calculus skills are developed and used throughout the course. The goal of this course is to prepare students to take the Advanced Placement Physics C: Electricity and Magnetism Exam.

Electrostatics

In this unit students will learn:

In Unit 1, students will begin the study of electric force, which acts on all objects with a property called charge. The electric force, in contrast to gravitational force, is one of attraction or repulsion and therefore leads to different effects on objects. This knowledge will help students understand the role electrostatics has in common devices such as photocopiers, defibrillators, and printers, as well as television, radio, and radar industries. In the units that follow, students will apply their knowledge of electric charges and force to electric circuits, and how the motion of electric charges helps create magnetic fields.

Standards

- 1.1 Charge and Coulomb's Law
- 1.2 Electric Field and Electric Potential
- 1.3 Electric Potential Due to Point Charges and Uniform Fields
- 1.4 Gauss's Law
- 1.5 Fields and Potentials of other Charge Distributions

Conductors, Capacitors, Dielectrics

In this unit students will learn:

Previously, students investigated why all objects have an electric charge. In Unit 2, students will examine how that charge can move through an object. Conductors, capacitors, and dielectrics are presented to demonstrate that a charge's movement is dependent on an object's material. In electronics, each of these are important based on the type of movement or desired object behavior. Additionally, this unit examines how the behavior of these elements is impacted by electric fields. Students should be provided with opportunities (laboratory investigations or activities) to describe and examine the function of each of these elements, along with capacitors. Knowledge of conductors, capacitors, and dielectrics will prepare students for understanding how electric circuits work in Unit 3 and how they behave when one or more electrical elements are altered or modified.

Standards

- 2.1 Electrostatics with Conductors
- 2.2 Capacitors
- 2.3 Dielectrics

Electric Circuits

In this unit students will learn:

Whether or not they're aware, students interact with electric circuits regularly through charging their phones, powering up their laptops, or simply switching on a light. Unit 3 serves to illuminate how, and why, our various appliances function by exploring the nature and importance of electric currents, circuits, and resistance. Through activities and lab investigations, students will have opportunities to relate knowledge across the course by using the electrical components they learned about in Unit 2 and will come to discover in Unit 3 to create, modify, and analyze circuits. Students will also analyze the relationships that exist between current, resistance, and power, in addition to exploring and applying Ohm's Law and Kirchhoff's Rules.

Standards

- 3.1 Current and Resistance
- 3.2 Current, Resistance, and Power
- 3.3 Steady-State Direct-Current Circuits with Batteries and Resistors Only
- 3.4 Capacitors in Circuits

Magnetic Fields

In this unit students will learn:

In previous units, students discovered that the electric field allows charged objects to interact without contact. Unit 4 introduces students to magnetism and how magnetic fields are generated, behave, and relate to electricity. Students will learn how magnetic fields impact motion and interact with other magnetic fields. Laboratory investigations and/or activities should be provided for students to apply both the Biot–Savart Law (using calculations to determine the strength of a magnetic field) and Ampère's Law (deriving mathematical relationships which relate the magnitude of the magnetic field to current). This knowledge from previous units helps students to make connections between electric fields and magnetic fields as well as between Gauss's Law and Ampère's Law.

Standards

- 4.1 Forces on Moving Charges in Magnetic Fields
- 4.2 Forces on Current Carrying Wires in Magnetics Fields
- 4.3 Fields of Long Current-Carrying Wires
- 4.4 Biot-Savart Law and Ampere's Law

Electromagnetism

In this unit students will learn:

Throughout the course, students explored the vital roles electricity and magnetism play in our daily lives. Unit 5 examines electromagnetism through the concept of electromagnetic induction and the application of Maxwell's equations. Through

activities and detailed laboratory investigations, students will study, apply, and analyze the concept of induction, as well as investigate the relationship between Faraday's Law and Lenz's Law. Additionally, students are expected to call upon their knowledge obtained in earlier units—particularly that of charges, currents, and electric and magnetic fields—to better understand Maxwell's equations and to be able to mathematically demonstrate, as well as reason with, how these fields are generated.

Standards

- 5.1 Electromagnetic Induction (Including Faraday's Law and Lenz's Law)
- 5.2 Inductance (Including LR Circuits)
- 5.3 Maxwell's Equations

AP Physics C: Mechanics

AP Physics C: Mechanics is equivalent to a first-semester college course in calculus-based physics. The course covers kinematics, Newtonian mechanics (including rotational dynamics and angular momentum), work, energy, momentum, oscillations and gravitation. Introductory calculus skills are taught as a part of the course and used throughout the year. The goal of this course is to prepare students to take the Advanced Placement Physics C: Mechanics Exam.

Kinematics

In this unit students will learn:

Although motion is considered an accepted phenomenon because it can easily be seen, discerning—and eventually understanding—why objects move requires more observation. Unit 1 introduces students to kinematics—particularly one-dimensional, two-dimensional, and projectile motion. Students will not only learn how to define each kinematic quantity (position, velocity, acceleration, and time), but also how to distinguish between them, and how to graphically and mathematically represent the relationships among them. Kinematics serves as a foundation for various physics principles and concepts, and in the units that follow, students are expected to call upon their knowledge of kinematic quantities to describe components of motion in a variety of scenarios, such as how acceleration is addressed with Newton's third law of motion.

Standards

- 1.1 Motion in One Dimension
  - Relationships among vector quantities
- 1.2 Motion in Two Dimensions
  - Relationship among vector quantities in multiple directions

Newton's Laws of Motion

In this unit students will learn:

To understand how and why objects move, students must first understand the role forces play in motion. Unit 2 investigates Newton's laws of motion, which describe the relationship among moving objects and the forces acting on them. Students will learn how forces can change the motion of an object (first law); about the relationship between force, mass, and motion (second law); and why balanced forces become unbalanced (third law). These laws form the foundation of classical mechanics, and in subsequent units, students will evolve their understanding by applying Newton's laws of motion to a variety of physics principles, including the conservation of energy (Unit 3), rotation (Unit 5), simple harmonic motion (Unit 6), and the orbital motion of satellites (Unit 7).

Standards

- 2.1 First and Second Law of Motion
- 2.2 Circular Motion
- 2.3 Third Law of Motion

Energy

In this unit students will learn:

Are you working hard, or hardly working? The answer depends on how you define work. In Unit 3, students will explore the relationship between work, energy, and power and will be introduced to the principle of conservation as a foundational model of physics, as well as the concept of work as an agent of change for energy. Students are not only expected to functionally define and calculate work, energy, and power, but must also be comfortable graphically and mathematically representing them. Understanding these relationships will help students make connections to other content presented in the course. For instance, students can use the concept of work to link the principles of energy transfer, forces, momentum, and certain kinematic equations.

Standards

- 3.1 Work-Energy Theorem
- 3.2 Forces and Potential Energy
- 3.3 Conservation of Energy
- 3.4 Power

Momentum

In this unit students will learn:

Have you ever wondered how a tennis player times a return shot? Alongside skill, players must consider a number of factors to estimate how far, fast, or high their swings should be. Unit 4 introduces students to these factors through the concepts of center of mass, impulse and momentum, and the conservation of linear momentum. Students will learn the relationship between impulse and momentum via application or calculations. The conservation of linear momentum and how it's applied to collisions is also addressed. Unit 4 offers a complete picture of the motion of a system, which is explored primarily through impulse and changes in momentum. Students will further their understanding of momentum and angular momentum in Unit 7 as they begin to articulate orbital and rotational motion.

Standards

- 4.1 Center of Mass
- 4.2 Impulse and Momentum
- 4.3 Conservation of Linear Momentum, Collisions

Rotation

In this unit students will learn:

In this unit, students will investigate torque and rotational statics, kinematics, and dynamics, in addition to angular momentum and its conservation, to gain an in-depth and comprehensive understanding of rotation. Students are provided with opportunities to make connections between the content and models explored in the first four units, as well as with opportunities to demonstrate the analogy between translational and

rotational kinematics. Unfortunately, when dealing with rotational motion, all the conceptual difficulties found in translational motion also have direct analogs. For example, if the angular velocity is zero, students often believe that the angular acceleration must also be zero. Astronomical phenomena (such as satellites in orbit) are explored in Unit 7 to build students' knowledge of angular momentum and its conservation.

Standards

- 5.1 Torque and Rotational Statics
- 5.2 Rotational Kinematics
- 5.3 Rotational Dynamics and Energy
- 5.4 Angular Momentum and Its Conservation

Oscillations

In this unit students will learn:

While earlier units focused on linear motion, Unit 6 pays close attention to the type of motion we experience when we talk or listen to music. Through the concept of oscillations, students are introduced to the model of simple harmonic motion (SHM), springs, and pendulums. Students will discover why some objects repeat their motions with a regular pattern. They will also apply the model of SHM, define the three kinematic characteristics (displacement, velocity, and acceleration), and practice representing them graphically and mathematically. During their study of oscillations, students will gain a more in-depth understanding of motion, making them better equipped to apply their knowledge of forces and motion to waves. Students will continue to expand on circular motion in Unit 7 as they explore celestial bodies and objects.

Standards

- 6.1 Simple Harmonic Motion, Springs, and Pendulums

Gravitation

In this unit students will learn:

Unit 7 investigates Newton's laws of gravity and the relationships shared between planets, satellites, and their orbits. Students will become familiar with the law of universal gravitation and how it can be applied to any pair of masses and will consider the motion of an object in orbit under the influence of gravitational forces. Additionally, students will be given opportunities to relate connected knowledge across units by applying and deriving Kepler's laws of planetary motion to circular or general orbits. Drawing such relationships will help elevate students' understanding of motion and force in various circumstances.

Standards

- 7.1 Gravitational Forces
- 7.2 Orbits of Planets and Satellites

Astronomy

Students will study all of the basic overarching topics surrounding the study of space and the celestial objects that inhabit it. Students will first learn about the basic topics of studying our solar system and skygazing, then move on to more intermediate topics such as scaling of the universe, the lifecycle of stars, the process of fusion in stars, the physics of black holes, the theories behind the history of the universe and space exploration. This course will serve as an introduction to the study of astronomy to either propel students to pursue deeper study post-secondary or to simply engage students in the wonders of the universe. In Astronomy, the simulation software “Starry Night” is used to further key concepts in astronomy.

Unit #1: Basics of Astronomy

In this unit students will learn:

1. Basic celestial objects
2. The construction of our solar system
3. The planets and their features
4. Skygazing fundamentals

Standards

- (OLSS) PS.U.1: History and formation of the solar system / universe

Unit #2: Scale of Astronomy

In this unit students will learn:

1. Units of measurement used in astronomy
2. Size and scale of the solar system
3. Galaxies
4. Size, scale and composition of the universe
5. Moon phases and calendars

Standards

- (OLSS) PS.U.1: History and formation of the solar system / universe
- (OLSS) PS.U.2: Galaxies

Unit #3: Stars

In this unit students will learn:

1. Life Cycle of a Star
2. Nuclear Fusion
3. Luminosity and HR Diagrams
4. Composition of the Sun
5. Particle Physics

Standards
• (OLSS) PS.U.3: Stars

Unit #4: Black Holes and String Theory
In this unit students will learn: 6. Quantum Mechanics & General Relativity 7. String Theory 8. Black Holes
Standards
• (OLSS) PS.U.3: Stars

Unit #5: Cosmology, Astrophysics & Technology
In this unit students will learn: 9. Theoretical History & Timeline of the Universe 10. Redshift / Blueshift 11. Orbits 12. Tools and Technology 13. Space Exploration
Standards
• (OLSS) PS.U.1: History and formation of the solar system / universe

Introduction to Engineering Design

This is the first course in the Project Lead the Way (PLTW) Engineering Pathway. This course is designed to introduce the field of engineering and engineering technology to students. Here we take an idea through the design process to document its development, fabricate, test, and present it as a solution. Students dig deep into the engineering design process, applying math, science and engineering standards to hands-on projects. Students work both individually and in teams to design solutions to a variety of problems using 3D modeling software, 3D printers, laser cutters, and other fabrication tools.

Unit 1: Design and Problem Solving

In this unit students will learn: Design Basics

Unit 1 provides an overview of the engineering design process and helps students develop an understanding of the purpose and practice of modeling in engineering communication. Students are introduced to modeling methods
and practice modeling skills important to the design of mechanical systems including technical sketching, 3D solid modeling and technical drawing using Computer-Aided Design (CAD), statistical analysis, and prototyping.
Emphasis is placed on building CAD skills applied throughout the course. In addition, students learn statistical techniques to evaluate design solutions and apply statistics to inform the design of a game.

Standards

- Lesson 1.1 Design Basics
- Lesson 1.2 Visualization and Solid Modeling
- Lesson 1.3 CAD Fundamentals
- Lesson 1.4 Product Improvement

Unit 2: Assembly Design

In this unit students will learn: Assembly Design

Unit 2 emphasizes the design of systems of components. Students are introduced to the concept of reverse engineering and how to investigate and document the design of multi-component systems. Students learn various techniques used to connect components in a system, how systems are designed to allow desired interaction between components, and how to identify and select the materials from which products are made. They are also introduced to methods to improve the manufacturability of a product and reduce production costs. Students learn to apply two methods to create 3D assembly models in CAD and apply those techniques to design and document assemblies.

Standards

- Lesson 2.1 Put it Together
- Lesson 2.2 Take it Apart

- Lesson 2.3 A Material World
- Lesson 2.4 Fix It

Unit 3: Thoughtful Product Design

Unit 3 introduces students to a broader interpretation of the word design to include universal principles that contribute to successful product design. Students are exposed to design principles (other than the visual design principles presented in Unit 2) that can impact the appeal, usability, safety, and sustainability of a product. Design topics that are introduced or reinforced include product life-cycle, sustainability, manufacturability, human centered design, and systems thinking.

Standards

In this unit students will learn:

Lesson 3.1 Responsible Design
Lesson 3.2 More Than Parts
Lesson 3.3 Solve a Problem

Unit 4: Making Things Move

Unit 4 focuses on familiarizing students with basic engineering knowledge related to simple mechanical and electrical systems and the use of mathematical models to represent design ideas and to inform design decisions.
Students will apply their new knowledge in the design of an electromechanical solution. Students also learn advanced CAD skills to support the design, documentation, and communication of engineering solutions.

Standards

- Lesson 4.1 You've Got to Move It
- Lesson 4.2 May the Force Be With You
- Lesson 4.3 Automating Motion
- Lesson 4.4 Make It Move

Principles of Engineering

This is the second course in the Project Lead the Way (PLTW) Engineering Pathway. Through problems that engage and challenge, students explore a broad range of engineering topics, including mechanisms, the strength of structures and materials, robotics, coding, and automation. Students will employ engineering and scientific concepts as they develop skills in problem solving, research, and design and manufacturing while learning strategies for design process documentation, collaboration and presentation.

Unit 1: Energy and Power

The goal of Unit 1 is to introduce students to mechanisms, energy sources, and alternative energy applications. Students will gain an understanding of mechanisms through the application of theory-based calculations accompanied by lab experimentation.

They will also learn that as energy and power are transferred and transformed, losses to friction in the system will occur. Students will understand that such losses affect the overall efficiency of the system. They will have an opportunity to investigate thermal energy and alternative energy applications. Students will explore and gain experiences relating to solar hydrogen systems and thermal energy transfer through materials.

The unit concludes with students working in teams to solve a design problem that focuses on energy and power. They will use the knowledge and understanding built through the previous learning events to create a solution to the problem.

Energy and Power Lesson Summary

- 1.1 Mechanisms
- 1.2 Energy Sources
- 1.3 Energy Applications
- 1.4 Design Problem – Energy and Power

Unit 2: Materials and Structures

The goal of Unit 2 is for students to have a more concrete understanding of engineering through materials properties and statics. Students begin by learning about beam deflection and then forces on truss structures. They learn to identify forces acting on those structures and then gain the ability to calculate internal and external forces acting on those structures.

The students learn about material properties, which lead students to the ability to properly select a material for a given task. Creating new products to meet a given need or want is not the only concern in this area of study. How to reuse/recycle materials for continued and unique uses is also learned.
The primary way of studying materials properties in this unit is through destructive and non-destructive material testing on various materials. Tensile testing is the major destructive test. Students are engaged in how machines perform these tests and use either a classroom

machine or a simulation to further their understanding of these processes.

This unit concludes with a design problem whereby students, working in teams, follow the design process to solve a design problem.

Standards

- 2.1 Statics
- 2.2 Material Properties
- 2.3 Material Testing
- 2.4 Design Problem – Materials and Structures

Unit 3: Control Systems

The goal of Unit 3 is for students to recognize the abundance of an infinite variety of computer use in our daily lives. Students learn to control mechanical systems by recognizing computer outputs and gaining an understanding of how to write code to control them. They additionally experiment with various input devices and learn how they can adapt computer code to control computer outputs.

Furthermore, students gain an understanding of fluid power, both hydraulic and pneumatic. They begin to recognize the power and control advantages of fluid power. The unit concludes with students working in teams to solve a design problem that focuses on using control systems. They will integrate their prior knowledge, skills, and understandings from Unit 1: Simple Machines, Unit 2: Material Properties, and this unit. Students will decide what input devices to use, how to code their use, and the various output devices necessary to create a solution to the problem.

Standards

- 3.1 Machine Control
- 3.2 Fluid Power
- 3.3 Design Problem – Control Systems

Unit 4: Statistics and Kinematics

In Unit 4 students are engaged in learning to use statistics to evaluate an experiment. Later, they begin a study of dynamics, specifically kinematics, and apply statistical skills to study freefall motion. Students use theoretical and experimental data as a basis for learning statistical analysis. By collecting, organizing, and interpreting the data, students build the skills needed to understand data results.

They further use these new skills and knowledge to design a vehicle that will propel itself. Later, students will address the problem of designing a machine to accurately launch an object a specified distance. Examining projectile motion is at the core of this design problem.

Standards

- 4.1 Statistics
- 4.2 Kinematics

Engineering Applications

This course will require students to work in teams on various (student and teacher) directed engineering projects. Students will apply and further develop the skills they have learned in prerequisite engineering classes as well as learn new skills to further their understanding of the Engineering Design Process. Students will use various resources and skills such as Vex Robotics, Arduino boards, Autodesk Inventor (or comparable 3D modeling software), various programming languages, documentations, communication and presentation skills, 3D printing and CNC machining to resolve real world problems.

Unit 1: Robotics and Programming

The goal of Unit 1 is to introduce students to programming, robotic control, sensor use, and logical programming. Students will work with Vex Robotics, Arduinos, Raspberry Pi, or similar equipment.

1. Develop programming skills.
2. Understand basic debugging procedures.
3. Learn to control miscellaneous motors, and servos to complete tasks.
4. Learn to interpret data from various sensors.
5. Learn to program a robot to interpret data from sensors to complete a task.

Lesson Summary

National Science Education Standards, NSTA

Science as Inquiry
• Understanding of scientific concepts.
• An appreciation of "how we know" what we know in science.
• Understanding of the nature of science.
• Skills necessary to become independent enquirers about the natural world.
• The dispositions to use the skills, abilities and attitudes associated with science.

Physical Science
• Position and motion of objects.
• Motions and forces.
Science and Technology
• Abilities of technological design.
• Understanding about science and technology.

Common Core State Standards for Mathematics, NCTM

Operations and Algebraic Thinking
• Use the four operations with whole numbers to solve problems.
• Generate and analyze patterns.
• Write and interpret numerical expressions.
• Analyze patterns and relationships.
Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and

progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-2)
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-3)

Common Core State Standards Connections:

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. *(HS-ETS1-1),*(HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),*(HS-ETS1-3)*

Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1),*(HS-ETS1-3),(HS-ETS1-4)*

MP.4 Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

Unit 2: Design and Fabrication

Students will design, fabricate, and test some object to meet some goal or to do some task. Object will be digitally modeled out of multiple parts. Assembled and tested to meet load requirements digitally. Students will learn to control computer manufacturing methods to fabricate the parts, and then carry out the fabrication using 3D printing or CNC machining. Students will assemble and test their prototypes.

1) Brainstorming and research to develop a solution to whatever problem they are given.
2) Drafting the parts to create their solution.
3) Creating a digital assembly to digitally test their solution.
4) Creating a machine tool path or equivalent controls to fabricate the parts.
5) Assemble the prototype solution and conduct a real world test.

Standards

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-2)
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-3)

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Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1),*(HS-ETS1-3),(HS-ETS1-4)*

MP.4 Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

Unit 3: Architecture

Students will be learning how to use an architectural design software to design a habitat to meet some goal or challenge.

1. Students will learn to use revit by completing an introduction project.
2. Students will learn about basic building and space requirements for people to live in. EX building codes, space requirements, Ect.
3. Students will design a project to meet some challenges.
4. Students will create documents to share information and features about their solution.
5. Students will export their design and tour it in virtual reality.

Standards / Goals

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Common Core State Standards Connections:

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

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Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)

MP.4 Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

Unit 4: Trebuchet

Students will learn the specific kinematics known about a trebuchet. They will then design one out of specified materials to launch a given projectile.

1. Mechanics of a trebuchet. Learn how they work, the different degrees of freedom, ratios of counterweight to load, and counterweight arm to load arm, how to make a sling.
2. Create virtual models to test geometry to attempt to find an optimal combination of lever arm lengths and masses.
3. Design a trebuchet based on your virtual models. Keep in Create an inventor assembly model of the model.
4. Fabricate designs using the allowable / provided materials.
5. Troubleshoot projects (Test performance, collect data on, reflect, and update designs)
6. Compete against classmates in evaluation of performance.

Standards

National Science Education Standards, NSTA

Science as Inquiry
• Understanding of scientific concepts.
• An appreciation of "how we know" what we know in science.
• Understanding of the nature of science.
• Skills necessary to become independent enquirers about the natural world.
• The dispositions to use the skills, abilities and attitudes associated with science.

Physical Science
• Position and motion of objects.
• Motions and forces.

Science and Technology
• Abilities of technological design.

• Understanding about science and technology.

Common Core State Standards for Mathematics, NCTM
Operations and Algebraic Thinking
• Use the four operations with whole numbers to solve problems.
• Generate and analyze patterns.
• Write and interpret numerical expressions.
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Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-2)
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-3)

Common Core State Standards Connections:

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),(HS-ETS1-3)

Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)

MP.4 Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

Unit 5: Labview

Students will explore the LabVIEW environment and interactive analysis, dataflow programming, and common development techniques in a hands-on format. Students will learn how to develop data acquisition, instrument control, data-logging, and measurement analysis applications. At the end of the course, students will be able to apply Labview, Daqs, and sensors to various engineering practices.

Standards

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)

Common Core State Standards Connections:

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),(HS-ETS1-3)

Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)

MP.4 Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

Unit 6 :Beginning Python with TCLAB

Students will learn Python code and basic elements to help with a temperature control project

1. To understand why Python is a useful scripting language for developers.
2. To learn how to design and program Python applications.
3. To learn how to use lists, tuples, and dictionaries in Python programs.
4. To learn how to identify Python object types.
5. To learn how to use indexing and slicing to access data in Python programs.
6. To define the structure and components of a Python program.
7. To learn how to write loops and decision statements in Python.
8. To learn how to write functions and pass arguments in Python.
9. To learn how to build and package Python modules for reusability.
10. To learn how to read and write files in Python.
11. To learn how to design object-oriented programs with Python classes.
12. To design a temperature controller. Temperature control is found in many applications such as home or office HVAC, manufacturing processes, transportation, and life sciences. Even our bodies regulate to a specific temperature.

This project is to regulate the temperature of the TCLab (Temperature Control Lab). Each TCLab has thermochromic (changes color with temperature) paint that turns from black to

purple when the temperature reaches the target temperature of 37°C (99°F)

Standards

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)

Common Core State Standards Connections:

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),(HS-ETS1-3)

Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)

MP.4 Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

Unit 7: Oscilloscopes and Arduino

Students will:

1. Learn what measurements an oscilloscope can make
2. Learn how to apply that knowledge to how electronic sensor devices work and can be troubleshooted.
3. Learn how to interpret an oscilloscope display
4. Learn how to measure signal amplitudes
5. Learn how to measure signal frequency
6. See phase shift of waveforms
7. Measure the phase shift between two waveforms
8. Analyze PMW signal response of LEDs and Servos
9. Decode, receive and transmit UART communication protocol

Standards

Constructing Explanations and Designing Solutions

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Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)

MP.4 Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

Unit 8 :Beginner's Guide to Aeronautics

Students will perform a series of simulations to explore the theory and practice of flight.

1. Explore the theory and practice of flight using Web-based and downloadable computer simulation programs.
2. Conduct experiments using a simulation.
3. Apply input variables into a simulation.
4. Analyze the graphical interpretations of a simulation.
5. Design Airfoil to specified constraints using Airfoil design software.
6. Test prototype airfoil in Computational Fluid program.
7. Test prototype airfoil in wind tunnel.

Standards

National Science Education Standards, NSTA

Science as Inquiry
• Understanding of scientific concepts.

• An appreciation of "how we know" what we know in science.
• Understanding of the nature of science.
• Skills necessary to become independent inquiries about the natural world.
• The dispositions to use the skills, abilities and attitudes associated with science.

Physical Science
• Position and motion of objects.
• Motions and forces.

Science and Technology
• Abilities of technological design.
• Understanding about science and technology.

Common Core State Standards for Mathematics, NCTM

Operations and Algebraic Thinking
- • Use the four operations with whole numbers to solve problems.
- • Generate and analyze patterns.
- • Write and interpret numerical expressions.
- • Analyze patterns and relationships.

Unit 9 :Control Systems Machine Control

Students will:
1. Choose appropriate input and output devices based on the need of a technological system.
2. Create a flowchart to describe an algorithm. • Create pseudocode to describe an algorithm.
3. Analyze and describe an algorithm represented as a flowchart or as programming code. • Create a computer program to implement an algorithm, including conditional statements and iterations.
4. Predict the behavior of a control system by examining the program it is going to execute.
5. Evaluate algebraic and logical expressions involving programming variables.
6. Use a variety of methods for finding, identifying, and correcting bugs in a program.
7. Design and create a control system, including the inputs, computer program, and outputs, based on given needs and constraints.
8. Brainstorm and sketch possible solutions to an existing design problem.
9. Create a decision-making matrix for a design problem.
10. Select an approach that meets or satisfies the constraints provided in a design brief.
11. Create a detailed pictorial sketch or use 3D modeling software to document a proposed design.
12. Present a workable solution to a design problem.

Standards

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Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)

MP.4 Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

Unit 10 :Hydraulics

Students will:

1. Identify devices that utilize fluid power.
2. Identify and explain basic components and functions of fluid power devices.
3. Differentiate between the characteristics of pneumatic and hydraulic systems.
4. Calculate values in a fluid power system utilizing Pascal's law.
5. Calculate flow rate, flow velocity and mechanical advantage in a hydraulic system.
6. Use engineering design process to design and build a hydraulic walker to project specifications.

Standards

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-2)
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student-generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-3)

Common Core State Standards Connections:

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

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MP.2 Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)

MP.4 Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

Forensic Science

This one semester course is an elective, inquiry-oriented science class that will focus on criminal forensics. Through a sequence of lab-based activities, students will gain an understanding and appreciation of the role of science in solving crimes. Topics may include fingerprinting, entomology, pattern impressions, blood-spatter, DNA, crime scene processing, ballistics, fiber and hair analysis, document analysis, anthropology, and arson.

Unit I: Introduction to Forensic Science

In this unit students will learn to:

1. Define observation, and describe what changes occur in the brain while observing.
2. Describe examples of factors influencing eyewitness accounts of events.
3. Compare the reliability of eyewitness testimony to what actually happened.
4. Relate observation skills to their use in forensic science.
5. Practice and improve your own observation skills

Standards

- Define forensic science.
- Discuss the various branches within the field of forensic science.
- Examine the history and development of forensic science, linking progress to improvements in technology and practice.
- Describe the role of a forensic scientist.
- Examine the structure and services provided by a crime laboratory.

Unit II: Introduction to Physical Evidence

In this unit students will learn to:

1. Define physical evidence.
2. Discuss the common types of physical evidence encountered at crime scenes.
3. Explain the difference between the identification and comparison of physical evidence.
4. Define and contrast individual and class characteristics of physical evidence.
5. List and explain the function of national databases available to forensic scientists.

Standards

- Define physical evidence.
- Discuss the common types of physical evidence encountered at crime scenes.
- Explain the difference between the identification and comparison of physical evidence.
- Define and contrast individual and class characteristics of physical evidence.
- List and explain the function of national databases available to forensic scientists.

Unit III: Intro to Lab Techniques

In this unit students will learn:

1. Distinguish between physical and chemical properties.

2. Describe presumptive and confirmatory tests.
3. Compare and contrast different types of microscopes.
4. Explain how qualitative analysis differs from quantitative analysis.
5. Differentiate between thin-layer chromatography, gas chromatography, and high-performance liquid chromatography.
6. Calculate R (retention factor).
7. List and describe three types of spectroscopy.
8. Compare and contrast techniques for visualizing fingerprints.
9. Describe the structure of DNA.

Standards

- Use diverse methods to obtain evidence and do not always use the same set of procedures to obtain and analyze data (i.e., there is no one scientific method).
    - Make observations and look for patterns.
    - Determine relevant independent variables affecting observed patterns.
    - Manipulate an independent variable to affect a dependent variable.
    - Conduct an experiment with controlled variables based on a question or hypothesis.
    - Analyze data graphically and mathematically

Unit IV: Scientific Crime Scene Investigation

In this unit students will learn:

1. Summarize Locard's Principle of Exchange.
2. Identify four examples of trace evidence.
3. Distinguish between direct and circumstantial evidence.
4. Identify the types of professionals who might be present at a crime scene.
5. Summarize the seven steps (seven S's) of a crime-scene investigation.
6. Explain the importance of securing the crime scene.
7. Identify the methods by which a crime scene is documented.
8. Demonstrate proper technique in collecting and packaging trace evidence.
9. Explain what it means to map a crime scene.
10. Describe how evidence from a crime scene is analyzed.

Standards

- Science disciplines share common rules of evidence used to evaluate explanations.
- Phenomenon by using empirical standards, logical arguments and peer reviews.
    - Empirical standards include objectivity, reproducibility, and honest and ethical reporting of findings.
    - Logical arguments should be evaluated with open-mindedness, objectivity and skepticism.
- Science arguments are strengthened by multiple lines of evidence supporting a single explanation.
- The various scientific disciplines have practices, methods, and modes of thinking that are used in the process of developing new science knowledge and critiquing existing knowledge.

Unit V-VIII: Student-directed Units
In this unit students will learn: 1. Dependent on student choice. Topics may include: ● Fingerprinting, entomology, pattern impressions, blood-spatter, DNA, physical trauma, ballistics, fiber and hair analysis, document analysis, anthropology, arson, criminal profiling…
Standards
● Science can advance through critical thinking about existing evidence. ● Science includes the process of comparing patterns of evidence with current theory. ● Some science knowledge pertains to probabilities or tendencies. ● Science should carefully consider and evaluate anomalies (persistent outliers) in data and evidence. ● Improvements in technology allow us to gather new scientific evidence.

Human Body Systems

This is the first course in the Project Lead the Way (PLTW) Biomedical Pathway. Students will understand human anatomy, physiology, and common diseases and disorders. Students examine the interactions of human body systems as they explore identity, power, movement, protection, and homeostasis in the body. Exploring science in action, students build organs and tissues on a skeletal Maniken®; use data acquisition software to monitor body functions such as muscle movement, reflex and voluntary action, and respiration; and take on the roles of biomedical professionals to solve real-world medical cases.

Identity
In this unit students will learn and investigate the body systems and functions that all humans have in common and then look at differences in tissues, such as bone and muscle, and in molecules, such as DNA, to pinpoint unique identity.
Standards
• Identify basic levels of organization of the human body. • Identify basic structures and describe functions of human body systems. • Describe the organization of the human body and directional terms.

Communication
In this unit students will learn and investigate modes of communication within the human body as well as the ways the human body communicates with the outside world. Students map the function of key regions of the brain and explore how the body detects, processes, and responds to internal and external stimuli.
Standards
• Identify organs of the nervous system. • Investigate functions of the nervous system including movement, sensation, and regulation of body processes by hormones • Identify structures of the special sense organs

Power
In this unit students will learn and investigate the human body systems that work to obtain, distribute, or process the body's primary resources for energy and power—food, oxygen, and water.
Standards
• Identify the structures of the digestive, urinary, and respiratory systems • Explore the components of chemical and mechanical digestion

- Evaluate the functions of the respiratory system and respiratory disorders such as asthma
- Explore the process of urine formation and urine composition

Movement

In this unit students will learn and investigate movement of the human body as well as the movement of substances within the body. By building muscle groups on a skeletal model, students learn how a muscle's structure is directly related to its function and to the actions it can produce.

Standards

- Identify types of muscle tissue
- Identify joint types and movement
- Evaluate the pathway of blood flow through the heart and body
- Distinguish between blood components and nutrients, waste, antibodies, hormones, and gases transported in the blood

Protection

In this unit students will learn and explore ways in which the human body protects itself from injury and disease. Students investigate specific defense mechanisms of the immune system, as well as protective functions of skin, bone, and the feeling of pain.

Standards

- Identify structures of the integumentary system
- Explore functions of the integumentary system including sensation, infection protection, temperature regulation, and UV light protection

Homeostasis

In this unit students will learn the connection between all of the human body systems and examine how the systems work together to maintain health and homeostasis.

Standards

- Promote behaviors of health and wellness. Including exercise, nutrition, and stress management.
- Demonstrate procedures for measuring and recording vital signs including blood pressure, temperature, pulse and pain.

Medical Interventions

This is the second course in the Project Lead the Way (PLTW) Biomedical Pathway. Students investigate how to prevent, diagnose, and treat disease. Students explore how to detect and fight infection, screen and evaluate the code in human DNA, evaluate cancer treatment options, and prevail when the organs of the body begin to fail. Through real-world cases, students are exposed to a range of interventions related to immunology, surgery, genetics, pharmacology, medical devices and diagnostics.

Unit 1: How to Fight Infection

In this unit, students are introduced to Sue Smith, the eighteen-year-old daughter of Mr. and Mrs. Smith. Sue is a college freshman who is presenting symptoms of an unknown infectious disease which students eventually identify as bacterial meningitis. Sue survives the infection but is left with hearing impairment. Through this case students will explore the diagnostic process used to identify an unknown infection, the use of antibiotics as a treatment, how bacteria develop antibiotic resistance, how hearing impairment is assessed and treated, and how vaccinations are developed and used to prevent infection.

Standards

- Analyze connections between patients in an outbreak situation, determine appropriate tests to identify the pathogen, and determine the steps for treatment and containment.
- Analyze disease data, design epidemiologic studies, and evaluate prevention and therapy for chronic and infectious diseases.
- Explain the principles of the Enzyme-linked Immunosorbent Assay (ELISA) test and interpret ELISA results to detect the presence and concentration of a pathogen.
- Use computer database technology to analyze genetic information and interpret results.
- Determine the hearing tests to diagnose sensorineural and conductive hearing loss.
- Interpret audiograms to identify different types of hearing loss and select interventions.
- Relate the structure of the ear to function and explain the pathophysiology of hearing loss.
- Describe the function of the major structures in the bacterial cell and how these structures provide the cell defense.
- Explain how the four main classes of antibiotics target specific bacterial structures and biological pathways.
- Compare the three types of bacterial gene transfer and the relationship of this transfer to antibiotic resistance.
- Describe the ways in which the misuse of antibiotics can impact bacterial growth.
- Explain how molecular tools, such as ligase and restriction enzymes, are used to cut and paste DNA from different sources.
- Describe how recombinant DNA technology can be used to produce vaccines.
- Insert plasmid DNA into bacterial cells in the laboratory and observe how this genetic information relates to new traits of the bacteria.
- Describe the various laboratory methods that are used to manufacture vaccines.
- Explain the impact vaccines have had on disease occurrence.

Unit 2: How to Screen What is in Your Genes

In this unit, students are introduced to Mr. and Mrs. Smith, Sue's parents. Mr. and Mrs. Smith are very excited to find out they are expecting a new baby. Because the couple is in their early 40s, the doctor has suggested genetic screening and testing. Through this case students will explore how to screen and evaluate the code in our DNA, the value of good prenatal care, and the future of genetic technology.

The goal of this lesson is for students to examine the available types of genetic testing and screening and discuss ethical implications of these tests. Assuming the role of genetic counselors, students will analyze a patient case concerning issues of genetic testing and provide appropriate recommendations. Next, students will explore molecular techniques necessary to complete a genetic test. They will use the tools of molecular biology to extract their own DNA, amplify a part of the gene for bitter-tasting ability, identify their own gene sequence by restriction digest, and view their resultant genotype using gel electrophoresis. Students then have a chance to test their own phenotype and see how well this genotype predicts their own ability. Finally, students will investigate the interventions that exist to help protect and monitor a growing fetus.

Standards

- Design and carry out an experiment that investigates a research question.
- Explain and conduct gel electrophoresis.
- Explain the applications of PCR technology as well as the role of each reagent in the process.
- Explain how reproductive technology works.
- Evaluate the promise and limitations of gene editing.
- Identify which restriction enzyme to use for a given situation.
- Identify single base- pair differences in DNA through laboratory techniques, such as DNA extraction, PCR, and restriction analysis.
- Interpret karyotype results and determine outcomes and options.
- Analyze personal and family medical history and genetic testing results to make a recommendation for a particular genetic counseling case.

Unit 3: How to Conquer Cancer

In this unit, students are introduced to Mike Smith, the sixteen-year-old son of Mr. and Mrs. Smith. Mike is diagnosed with osteosarcoma, a type of bone cancer that often affects teenagers. Mike's treatments put him into remission; however, in order to remove all of the cancerous tissue, he had to have most of his arm amputated. Mike now needs a prosthesis. Through this case students will explore the diagnostic process used to determine the presence of cancerous cells, the risk factors and prevention of cancer, rehabilitation after disease or injury, and the design process for new medications, prosthetics, and nanotechnology.

Standards

- Explain how DNA microarrays are used to compare gene expression (mRNA expression) between different tissue samples or sample groups.

- Describe how microarray data can be used to evaluate cancer risks.
- Demonstrate proper usage of a microscope.
- Analyze the difference between normal cells and cancer cells.
- Describe the different uses for X-rays, bone scans, CT scans, and MRIs, as well as how each technology works.
- Connect cell cycle regulatory gene mutations to the development of cancer.
- Describe the behavioral, biological, environmental, and genetic risk factors that can increase the chance that a person will develop cancer.
- Evaluate genetic risk factors for cancer using family history and marker analysis.
- Evaluate the benefits and side effects of cancer treatments.
- Describe how myoelectric prosthetic limbs work to restore function to patients who have lost a limb.
- Differentiate between physical and occupational therapy.
- Explain how biofeedback therapy can improve health and/or manage pain.
- Identify single base- pair differences in DNA through laboratory techniques, such as DNA extraction, PCR, and restriction analysis.
- Predict how a person will respond to particular medications based on the patient SNP profile.
- Explain how SNPs can be identified through genetic testing and how they correlate to specific diseases or traits.

Unit 4: How to Prevail when Organs Fail

In this unit, students are introduced to Mrs. Jones, the forty-four-year-old sister of Mrs. Smith. Mrs. Jones has been struggling with Type 1 Diabetes for twenty years. Over the years, Mrs. Jones did not take good care of herself or properly control her diabetes. She eventually began using an insulin pump and changed her lifestyle to regulate her blood sugar levels, but the damage had already been done. Mrs. Jones is now dealing with end stage renal failure and needs a kidney transplant. Through this case students will explore protein production, blood sugar regulation, dialysis, organ donation and transplantation, and non-invasive surgery techniques. In addition students will create a bionic human.

The goal of this lesson is for students to investigate the biomanufacturing of human proteins used for medical interventions. They will first use the process of bacterial transformation to insert a plasmid containing the gene for green fluorescent protein (GFP) into E. coli cells. Students will then use chromatography to separate the GFP protein from the other proteins in the bacterial cells. They will collect proteins in differential fractions and analyze the contents of these fractions using gel electrophoresis. Students will relate their molecular work to the case of Diana Jones, who is a Type 1 diabetic on insulin therapy. Without insulin produced by the biomanufacturing process explored in this lesson, she would have died long ago. As the unit progresses, students will research and design other medical interventions that will help Diana in her battle with diabetes and renal failure.

Standards

- Explain and conduct gel electrophoresis.
- Describe and apply aseptic techniques for handling and culturing microbial samples.
- Describe the skill, dexterity, and eye-hand coordination necessary to complete surgical techniques.

- Match an organ donor with a compatible recipient based on blood typing and HLA typing results.
- Identify symptoms of End Stage Renal Disease (ESRD).
- Analyze the pros and cons of hemodialysis, peritoneal dialysis, and kidney transplant for a patient with ESRD.
- Compare the three types of bacterial gene transfer and the relationship of this transfer to antibiotic resistance.
- Outline the steps required to produce a protein in the laboratory.
- Isolate a protein based on its properties using column chromatography
- Verify an isolated protein using protein electrophoresis.

Nutritional Biochemistry

Nutritional Biochemistry is an elective course where students explore the everyday science behind the integral role nutrition serves in health and wellness. Students will learn about macronutrients, micronutrients and phytochemicals, dietary lifestyles, critical biochemical pathways that regulate blood sugar, blood lipids, and overall cardiovascular health. Students will investigate the history of the food industry and dietary recommendations, dietary trends, along with food engineering and safety. Eating for optimal athletic performance, supplements, wellness, and healthy aging will also be covered. Students will explore these topics in the classroom, chemistry lab, and the kitchen.

Introduction to Nutrition

In this unit students will learn:

1. Macronutrients
2. Micronutrients
3. Phytochemicals
4. Review of Chemistry
5. Food Log
6. Nutrition Labels
7. Calorie (kcal)
8. Serving Sizes vs. Portion Size
9. Introduction to Meal Planning

Introduction to Human Anatomy and Physiology

In this unit students will learn:

1. Basic structures and functions of the Human Body Systems.
2. Levels of structural organization in human anatomy and physiology.
3. The integral role of the digestive system in health and wellness.
4. How hormonal and neural feedback loops regulate blood sugar, blood pressure, appetite, thirst, and other homeostatic mechanisms..

Proteins

In this unit students will learn:

1. The critical role that protein plays in human nutrition.
2. The protein content of common dietary elements.
3. Protein needs throughout lifespan and lifestyle.
4. Ingestion, digestion, absorption, and protein metabolism.
5. Enzymes are proteins.
6. Role of dietary protein quantity and timing in muscle protein synthesis.
7. The Central Dogma of molecular genetics: DNA→RNA→ Protein.

Carbohydrates

In this unit students will learn:

1. Carbohydrates are the preferred fuel source for production of ATP in cells.
2. Monosaccharides and disaccharides are considered simple sugars.
3. Simple sugars are naturally found in food and are often added to processed foods and beverages.
4. Simple sugars can have a significant impact on blood glucose levels and insulin response.
5. Polysaccharides are considered complex carbohydrates.
6. Starch (pectin and amylopectin) is a digestible source of carbohydrates found in plants.
7. Fiber (cellulose) is an insoluble polysaccharide found in plants that does not provide energy directly but is vital for gut health.
8. Glycogen, a polysaccharide, is stored in animal muscle and liver cells, respectively.
9. Liver glycogen supports blood glucose levels, muscle glycogen provides glucose and hence ATP to muscle cells.
10. Consumption of Simple sugars (sucrose, high fructose corn syrup,etc.) in processed foods may play a significant role in the global obesity epidemic.

Lipids

In this unit students will learn:

1. Lipids are a broad category of biochemicals that serve a multitude of roles in human biology.
2. Fatty acids serve as fuel for oxidative phosphorylation and the production of ATP.
3. Some cell types situationally prefer to consume fatty acids over carbohydrates for fuel.
4. Many lipids are sterols that serve as precursors for hormones, neurotransmitters, etc.
5. Disorders of lipid metabolism are understood to contribute to arterial diseases.
6. Lipoproteins are conjugate lipid-protein complexes that can act as markers of cardiovascular health.
7. The 1980’s low fat movement in the food and nutrition industry has had a lasting impact on consumer behavior and health.
8. Fatty acids can be classified as saturated, unsaturated, or trans.
9. Trans fats are banned in the United States.
10. Unsaturated fatty acids can further be categorized as polyunsaturated or monounsaturated. Omega-3 and Omega-6 PUFA’s are essential.
11. The ratio of Omega-3 to Omega-6

Vitamins and Minerals

In this unit students will learn:

1. Vitamins are essential organic molecules that naturally occur in foodstuffs.
2. Vitamin deficiencies can lead to disease states that can be addressed by reintroducing the deficient compound.
3. Vitamins aid in vital chemical pathways, and can act as antioxidants in cells, offering protection from free radicals.

4. Free radicals are natural byproducts of biochemical pathways. Pollution, toxins, stress, smoking, etc. can increase free radical production, accelerating disease and aging processes.
5. Minerals are essential, inorganic elements that naturally occur in foodstuffs.
6. Minerals often are associated with complex proteins and have specific biologic functions.
7. Bone, teeth, and connective tissues involve a collagen based framework with calcium and phosphorus.
8. Hemoglobin is the oxygen transporting molecule of Red Blood Cells.
9. Minerals act as coenzymes in hundreds of different cellular reactions.

Phytochemicals

In this unit students will learn:

1. Phytochemicals are plant based molecules that enhance and benefit cellular processes, allowing humans to thrive, and not merely survive.
2. Phytochemicals are often associated with colorful pigments (red, orange, purple, green).
3. Phytochemicals are not essential, as no disease states result from a deficiency.
4. Phytochemicals can act as antioxidants.
5. Phytochemicals can impart distinct flavors and fragrances to foods.
6. Functional Foods are those food items that are thought to impart specific benefits and health enhancements.

Food Safety and Engineering

In this unit students will learn:

1. Man has been manipulating plants and animals with agricultural practices (hybridizing, cross-pollinating, selective breeding) since civilization began.
2. What organic means and does not mean at the grocery store.
3. Details of the USDA National Organic Program
4. Modern conventional farming utilizes pesticides, herbicides, some genetically modified crops, and oftentimes modern farms produce a monoculture.
5. Foodborne pathogens are a significant cause of illness and carry significant economic consequences.
6. Food Safety Practices such as proper purchasing, processing, preparing, and storing. Preventative measures are emphasized in the classroom and food lab settings.
7. Signs, symptoms, and causes of foodborne illness.

Public Health and Nutrition

In this unit students will learn:

1. Body Mass Index
2. Basal Metabolic Rate and Total Metabolic Rate
3. Obesity rates and trends in the United States and World.

4. To critically examine our modern food environment, consumer behavior, governmental policies and oversight of the private food processors.
5. Body composition differences by gender and age.
6. Critically examine the relationship between body composition and health outcomes and lifespan.
7. Specific dietary plans will be examined: veganism, vegetarianism, carnivore, omnivore, gluten-free, etc.
8. Nutrition for Athletes: speed and power versus endurance, strength training, physique competition, etc.

Introduction to Sports Performance and Nutrition

In this unit students will learn:

1. How nutrition can enhance or detract from efforts on the field, in the gym, and in the performance training center.
2. How to construct meal plans for athletes of varying age, gender, sport/training method, and goal (weight loss, weight gain, weight management)
3. Varying macronutrient splits will be scrutinized with pros and cons for each being discussed.
4. Quantity and timing of macronutrient consumption pre and post workout can impact performance and recovery.
5. Water plays a critical role in the health, wellness, and performance of athletes.
6. Proper sleep behavior is essential for optimal performance and health.
7. Popular sports/performance/wellness nutritional supplements will be explored, understood, and scrutinized.

Resource Materials

Grade/Course	Resource	Publisher
Kindergarten - 5th Grade	Mystery Science - Aligned to Ohio Standards	https://mystery.com/
4th and 5th Grade	Investigation Science Workbook as a one time purchase resource	Savvas
6th - 8th Grade Science	Elevate Science Courses 1-3 Textbook	Savvas
CP/Hon Biology	Miller & Levine Biology Textbook	Savvas
AP Biology	Biology for the AP Course Textbook	BFW Publishers
CP/Hon Chemistry	Discovery (Online resource)	Discovery Learning
AP Chemistry	Chemistry: The Central Science Textbook	Savvas
Human Body Systems, Medical Interventions, Introduction to Engineering/Design, Principles of Engineering	Project Lead the Way Curriculum	Project Lead the Way
Forensics	Forensic Science: Fundamentals and Investigations Forensic Science: Advanced Investigations	Cengage