
Diocese of Trenton
PreK-12 Science Curriculum Guidelines 2019

Introduction to the Newly Revised Diocesan Science Curriculum

“All of our Creation reveals the Glory of God to all of us,” this quotation reminds us that first and foremost the study of science is grounded in the world that God created that is expressed so beautifully in the Book of Genesis in the Bible. Pope Francis re-iterated that premise in the *Laudato Si* encyclical that explored the riches of nature in all creation.

In designing and developing these new science guidelines for our teachers and students in the Diocese of Trenton, the members of the diocesan curriculum committee accepted this fact as a foundational premise of these guidelines.

These curriculum guidelines are based on the ***National Standards and Benchmarks for Effective Catholic Elementary and Secondary Schools***, ***Next Generation Science Standards***, ***NJ Student Learning Outcomes,*** current science research, science research in the current diocesan science guidelines, and teacher expertise.

Incorporated in these curriculum guidelines are topics and strategies to guide the teachers in lesson planning and the students in developing their cognitive understanding of the importance of science education in the complete learning process.

Curiosity, radical imagination, and innovation are hallmarks of science education for envisioning the future educational development of our students. Science Technology Engineering Mathematics (STEM) education is infused in the guidelines as well as an understanding that mathematic classes provide appropriate skills to organize and calculate the results of experiments and reach conclusions. Science education today is not a separate discipline but is found incorporated in a multitude of areas.

This document looks at science education through such skills as gathering facts, bringing questions in nature into focus, writing a hypothesis, following through with proper problem-solving techniques, and justifying conclusions.

It is very important that every elementary faculty member review these guidelines and that all members of the secondary science and math departments are familiar with them.

Vision & Mission Statement

Vision Statement

As educators in the Catholic schools of the Diocese of Trenton, we strive to provide all students with the opportunity to become scientifically literate in order to understand their world and to make effective and responsible contributions to their communities. All students are encouraged to develop an appreciation for the great diversity of life found on Earth and commit themselves to respect and be stewards of God's creation as we strive to produce a sustainable environment.

According to Pope Francis in his new encyclical *Laudato Si,* we must remember that "nature is usually seen as a system that can be studied, understood and controlled, whereas creation can only be understood as a gift from the outstretched hand of the Father of all and as a reality illuminated by the love that calls us together into universal communion".

Mission Statement

The mission of the Diocese of Trenton for Science curriculum is to honor, enhance, cultivate and encourage the innate natural curiosity of all students in the Catholic school community within an ever-changing global world.

Flowing out of the Mission Statement are the following goals and objectives:

1. To teach science as inquiry learning
    - Students are actively engaged in the learning process through questioning, investigating and collaborative problem solving
    - Students know how to apply the scientific method to various areas of their lives and to approach problems in an organized, logical and creative manner
    - Students develop skills to make science relevant to the scientific community
2. To foster an understanding and appreciation of the interrelationships among species and ecosystems
    - Students develop respect and appreciation for biodiversity

- Students learn and understand the association among humans, other species and ecosystems

3. To help students develop attitudes and behaviors that impact positively on the world outside their classrooms
    - Students should have resources appropriate to a learning process that prepares them to live and work in a challenging global world
    - Students develop skills that enable them to adapt and thrive in an ever-changing world
4. To provide students with the knowledge and skills needed to analyze information, make informed decisions, and take actions that address real world issues of sustainable development and environment ethics
    - Students, as members of a global society, think critically about issues and come to ethical, responsible decisions based on Catholic values
    - Students recognize that learning is part of their everyday life
5. To vary methods of assessment
    - Teachers use a variety of formal and informal methods including formative, summative and associative methods of assessment
6. To develop a plan to integrate science throughout the curriculum and to ensure the appropriate articulation between levels
    - Curriculum coordinators/department chairs hold regularly scheduled meetings throughout the year
    - Elementary and secondary teachers meet to strengthen the articulation between levels
7. To support the use of digital technology including but not limited to: computers, iPads, probes, digital metrics, integrated white boards, robots, digital cameras
    - Students will regularly and routinely use technology and manipulatives as integral part of both instructional and assessment activities
8. Students may perform dissection for scientific purposes following Elementary and Secondary guidelines
    - Elementary students can be taught an appreciation of various species such as squid, crayfish, and other invertebrates
    - Dissection of vertebrates should be reserved for upper level secondary science classes
9. Utilize proper disposal of hazardous scientific materials according to local protocols
    - Access the Association of New Jersey Household Hazardous Waste Coordinators (ANJHHWC) to learn of the county's protocol https://njhazwaste.com/counties/

Note Regarding Dissection:

The Diocese of Trenton is dedicated to teaching and developing responsible attitudes and a general respect and reverence for all living organisms. We also recognize the historical and current importance of animals in the field of science, especially in the area of research. After careful consideration of various current views, the curriculum committee highly encourages the following guidelines be adapted in all Diocesan science classes.

- Dissection should only be considered for upper level instruction and must only be used if there are no other acceptable alternatives for teaching the relationship of structure and function.
- No students should be forced to participate in any dissection; alternative methods must be made available, e.g., computer software, Internet activities, for students to study the anatomy of both vertebrate and invertebrate species. All students whether or not they participate in a class lab, should be held responsible for the academic material. The use of vertebrates in student research must be limited to advanced science courses and they should strive to utilize the least sentient vertebrate that applies to the research.
- Invertebrate dissections may be undertaken for scientific purposes when possible. All selected dissections should be part of the curriculum and the seriousness of the activity should be stressed to the students. Always stress safety and teach the proper use of dissection tools and proper disposal of laboratory materials.
- When conditions permit, living organisms, both plant and animal should be kept in the classroom where students can experience and learn to appreciate various species, as well as, care for them and study their behavior. State and local regulations for the care of these animals should be enforced at all time. Studies should also occur in natural habitats.

Gratitude

Gratitude is simply defined in the American Heritage dictionary as thankfulness. Saying thank you for this document does not begin to explain the amount of time, expertise, research and willingness of the educators who designed and completed this science document.

The members of the committee, all science educators, represented the elementary and secondary grade levels in the schools in the Diocese. Every educator was deeply committed to this process, and has multiple years of experience in science education.

They embraced the concepts of science education as noted in the Vision and Mission for ensuring that the students, in Pre-K through 12 received a rigorous academic education in Physical, Life and Space and Earth science.

The members of the Department of Education extend their deep appreciation for the completion of this document and we wish each of you all God's blessings as you continue to educate our elementary and secondary students.

Each of you have served well in bringing the grandeur of God's world to our students.

Acknowledgements

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National Standards and Benchmarks for
Effective Catholic Elementary and Secondary Schools

Life Science, Physical, and Earth Science

7.1 Curriculum adheres to appropriate, delineated standards, and is vertically aligned to ensure that every student successfully completes a rigorous and coherent sequence of academic courses based on the standards and rooted in Catholic values.
7.2 Standards are adopted and across the curriculum, and include integration of the religious, spiritual, moral, and ethical, dimensions of learning in all subjects.
7.3 Curriculum and instruction for 21st century learning provide students with the knowledge, understanding and skills to become creative, reflective, literate, critical, and moral evaluators, problem solvers, decision makers, and socially responsible global citizens.
7.4 Curriculum and instruction for 21st century learning prepares students to become expert users of technology, able to create, publish, and critique digital products that reflect their understanding.
7.5 Classroom instruction is design to intentionally address the affective dimensions of learning, such as intellectual and social dispositions, relationship building and habits of mind.
7.6 Classroom instruction is designed to engage and motivate all students addressing the diverse needs and capabilities of each student, and accommodating students will special needs as fully as possible.
7.9 Faculty and professional support staff demonstrate and continuously improve knowledge and skills necessary for effective instruction, cultural sensitivity, and modeling of Gospel values.

Science Inquiry with STEM Integration
Practical Inquiry Strategies to Develop Problem Solvers

DIOCESAN OBJECTIVE:
Students will develop strategies and skills necessary to apply the scientific method and demonstrate the ability to apply it to real world settings using AdvancED and NGSS strategies.
AdvancED STEM Standard and Indicators
http://www.advanc-ed.org/sites/default/files/documents/state-resources/STEM%20Standard_web-ready.pdf

STANDARD: STEM students have the skills, knowledge, and thinking strategies that prepare them to be innovative, creative, and systematic problem-solvers in STEM fields of study and work.

STEM LEARNERS
ST1.1 The STEM school/program supports non-traditional student participation through outreach to groups often underrepresented in STEM program areas.
ST1.2 Students work independently and collaboratively in an inquiry-based learning environment that encourages finding creative solutions to authentic and complex problems.
ST1.3 Students are empowered to personalize and self-direct their STEM learning experiences supported by STEM educators who facilitate their learning.
ST1.4 Students use technology resources to conduct research, demonstrate creative and critical thinking, and communicate and work collaboratively.
ST1.5 Students demonstrate their learning through performance-based assessments and express their conclusions through elaborate explanations of their thinking.

STEM EDUCATORS

ST1.6 The interdisciplinary problem-based curriculum includes a focus on real world applications.
ST1.7 STEM educators collaborate as an interdisciplinary team to plan, implement, and improve integrated STEM learning experiences.
ST1.8 STEM learning outcomes demonstrate students' STEM literacy necessary for the next level of STEM learning and for post-secondary and workforce readiness.
ST1.9 STEM teachers and leaders participate in a continuous program of STEM-specific professional learning.

STEM EXPERIENCES

ST1.10 Community, post-secondary, business/industry partners and/or families actively support and are engaged with teachers and students in the STEM program.
ST1.11 Students are supported in their STEM learning through adult-world connections and extended day opportunities.

NEW JERSEY CORE CURRICULUM CONTENT STANDARDS - TECHNOLOGY

Standard 8.2 Technology Education, Engineering, Design, and Computational Thinking - Programming:
All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the Environment.

Strand A. The Nature of Technology: Creativity and Innovation Technology systems impact every aspect of the world in which we live.

Next Generation Science Standards (NGSS)

To find the Disciplinary Core Ideas and Cross-Cutting Concepts, see grade level breakdown tables NGSS/NJCCCS 2016, which can be located on the internet.

The NGSS lists the standard with the following coding system: Grade Level-Branch of Science-Standard Number
Example: **K-LS1-1** Means Kindergarten Life Science Standard 1-1

ENGINEERING DESIGN PROCESS (NGSS)

K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

MATH ASPECTS OF SCIENCE

CORE CONTENT	ASSESSMENT STRATEGIES	INSTRUCTIONAL STRATEGIES
● Metric measurement	● Measure using standard and non-standard tools ● Measure in metric units	● Explore the concept of measurement by measuring objects using standard measuring tools such as rulers and non-standard tools such as straws and paper clips
● Tables, charts and graphs	● Make a class table of data collected ● Chart the results of the table ● Draw and label graphs	● Collect objects and sort and chart by the physical properties ● Use graph paper and a ruler to graph the temperature over a week ● Use a spreadsheet program to create digital graphs

Grade PRE-K Science Curriculum

Outcomes by End of 2nd Grade		
Physical Science ❏ Observe and list properties of matter discernible by using the five senses ❏ Understand that force can affect the position and motion of an object ❏ Recognize that energy exists in the forms of heat, light and electricity	***Life Science*** ❏ Recognize the processes of photosynthesis and plant and animal reproduction ❏ Recognize the five major body systems and their parts ❏ Demonstrate a respect for the sacredness of life ❏ Understand populations and ecosystems categorize organisms by kingdom and classes of vertebrates	***Earth and Space Science*** ❏ Observe and record various weather conditions ❏ Identify the four seasons ❏ Compare and contrast the four seasons ❏ Name the days of the week and the months of the year ❏ Identify the objects in the day and night sky ❏ Observe and describe patterns of change in the physical world ❏ Recognize different kinds of maps ❏ Investigate space exploration

Grade PRE-K Science Curriculum

Science Grade Preschool Overview

Preschool is a magical learning adventure for three and four-year-old students. With a play-based, developmental curriculum that meets the needs of each child, their first school experiences will be positive and joyful. They will learn about kindness, friendships, and self-reliance. They will learn how to take care of themselves and how to be a good friend. They will learn the importance of listening and the feeling of completing tasks by themselves. Along with building a strong sense of self, they will also feel safe physically, intellectually, and socially. They will learn how to write their name, recognize shapes, colors, numbers, and letters. They will show their skills in using scissors, paints, and different mediums. Play is an important asset to learning, and preschool science can utilize play to teach and assess science by playing indoor and outdoor games, using tablets, puzzle solving, problem solving, letter recognition, phonics, and simple counting.

Community Helpers

Call upon your community to help reinforce your science teaching. Invite local professionals to help educate by designing activities to increase science, technology, engineering, and mathematics literacy and enthusiasm among students, their families, and educators.

- Fireman or Police Officer teaching safety and showing their equipment to keep community safe
- Chef teaching about measurements
- Lifeguard teaching about water safety
- Nurse teaching how to take a pulse and listen to the heart
- F.B.I. agent teaching about forensics with finger printing
- Architect teaching about design and construction

Grade PRE-K Science Curriculum

Science Grade Preschool Overview

Physical Science	Life Science	Earth and Space Science
1. **Structure of Atoms:** *Not introduced* 2. **Structure and Properties of Matter** ● Observable physical properties 3. **Chemical and Physical Changes** ● Changing properties of matter 4. **Motion and Forces** ● Push and pull 5. **Energy and their Interaction with Matter** ● Sound energy- sense of hearing ● Wind energy	1. **The Cell:** *Not introduced* 2. **Reproduction and Heredity/Genetics** ● Plants and animals resemble their parents 3. **Evolution:** ● Environment affects the survival of plants and animals ● Plants and animals have traits that help them survive 4. **Interdependence & Behavior of Organisms** ● Different kinds of plants and animals are found in different habitats ● Recognize living and nonliving things ● Differentiate between plant and animal life 5. **Matter, Energy, and Organization in Living Systems:** *Not introduced*	1. **Composition of the Earth and the Dynamics that Shape it** ● Weather ● Seasons 2. **Origin and Evolution of the Universe** ● Days of the week and the months of the year 3. **Space Exploration** ● The solar system
Physical Science **Essential Question**	Life Science **Essential Question**	Earth and Space Science **Essential Question**
How does science help you explore, observe, and understand your world?	What patterns can you find in nature?	How does weather affect the clothing you wear?

Grade PRE-K Science Curriculum
Physical Science Key Areas and Content Topics

1. STRUCTURE OF ATOMS: *Not introduced*

2. STRUCTURE AND PROPERTIES OF MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Observable physical properties	● Understand how objects are described based on their physical properties and how they are used ● Discuss the properties of matter after interacting with it, e. g., *size, color, shape, texture, weight and flexibility* ● Compare and contrast materials of different textures e. g., clay, wood, cloth, paper, etc.	● Explain how the five senses: sight, hearing, touch, taste, and smell help teach us about physical properties ● Use a touch box to describe different "mystery matter", e.g., *cooking oil vs water, rock vs. sand, or helium filled balloon* by their properties. ● Explain how some materials are sturdy and others are flexible ● Be able to classify a set of objects according to physical properties, e. g., *sort blocks, plastic animals, materials with different textures, to size and/or color*	**2-PS1-2** Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

3. CHEMICAL AND PHYSICAL CHANGES

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Changing the properties of matter	● December, January and February are filled with snow and ice project- Freeze melt or boil water ● Look at snowflakes under the microscope ● Show pictures of frozen, melted, or gaseous substances	● Show and Tell solid liquid gas ● Create a snowflake with salt water solution, Borax, and pipe cleaners. Crystals form before our very eyes. ● Build snowmen outside as well as sock versions in the classroom ask them where the snowman went when weather warms	**2-PS1-3.** Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

4. MOTION AND FORCES

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Push or Pull	● How to apply a push or pull to get the toy moving ● Design motion or speed demonstration with transportation gives the children a chance to understand how and why objects move. Trains, planes, boats (buoyancy and wind) and trucks are powered in different ways ● Read “Apples Up On Top” by Dr. Seuss. balance apples on head teach about balanced unbalanced forces	● Describe motion in terms of objects ● Talk about what they observe about motion while they play ● Design a juice box sailboat have them use wind energy to propel boat ● Compare and contrast push pull and motion vs no motion use toys and free play to test	**K-PS2-1.** Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. **K-PS2-2.** Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

5. ENERGY AND ITS INTERACTION WITH MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Sound Energy: Senses ● Wind Energy	● Mystery box ● Create/use pinwheels, kites, whirly bird seeds	● Link with Music teacher to create simple instruments (oatmeal box drum, stretched rubber band, beads) ● Go outside on a windy day with objects that show wind resistance	**1-PS4-1** Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

Grade PRE-K Science Curriculum
Life Science Key Areas and Content Topics

1. **THE CELL:** *Not introduced*

2. REPRODUCTION AND HEREDITY/GENETICS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Plants and animals resemble their parents	● Watch Videos, read children's books that demonstrate variation among animals of the same species by Steve Jenkins or Eric Carle ● Use a thematic unit like a farm to compare mother animals and their offspring	● Parent/offspring matchup (given pictures of animals, match up parent and offspring) ● Draw family pictures, or bring in photos, observe similarities and differences within a family ● Adopt a farm animal for an underserved family use a resource like *Heifer International* ● Use Mother's Day and Father's Day to discuss inheritance	**K-LS1-1** Use observations to describe patterns of what plants and animals (including humans) need to survive.

3. **EVOLUTION**

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
• Environment affects the survival of plants and animals and resources for energy and growth (*food, water, light, air, home)*	● Use a SMART Board, the Comparing Human and Plant Needs ● As seasons change collect signs of nature outside pinecones, feathers, and holly branches ● Talk about the human body and environmental effects like a cut or sunburn ● Survival is hard in different climates focus on Desert, Arctic regions	● Collect signs of nature, check them out under magnifying glasses classify them as plant or animal ● Publish a Boo-Boo Book ● Publish a Desert or Arctic animal book ● Discuss basic needs required by plants and animals for growth	**K-LS1-1** Use observations to describe patterns of what plants and animals (including humans) need to survive.
● Plants and animals have traits that help them survive	● Read: *What Do You Do with a Tail Like This?* or *Never Smile at a Monkey: And 17 Other Important Things to Remember* by Steve Jenkins ● Study fish in an aquarium and learn ways in which fish are adapted to live in water ● Discuss a list of differences between plants and animals ● Care for classroom plants and animals	● Design a new animal with a new trait to help them survive ● Identify parts of a favorite animal that were used for protection, movement and feeding	**2-LS4-1** Make observations of plants and animals to compare the diversity of life in different habitats.

4. INTERDEPENDENCE & BEHAVIOR OF ORGANISMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Different kinds of plants and animals are found in different habitats	● Talk about the habitat of the farm or jungle e.g., piglets on a farm to sunflowers, apples, pears, and pumpkins. ● Teach an animal or plant life cycle ● Halloween provides a background for the study of bats and spiders. Children become amateur zoologist learning about nocturnal behavior, echolocation and web spinning. ● Teach letters using examples of plants and animals according to the habitat in which they live ● Migration is another signal of the arrival of colder days. ● Hibernation follows as we learn how other animals prepare for the winter. ● Discuss the snow, and what different creatures do in the winter to survive ● Study marine biology or lake systems explore under the sea creatures	• Identify and compare the various habitats in which animals and plants live on the farm or the jungle • Take a trip to an Apple Orchard or Pumpkin Patch • Draw a seed to sprout book • Sing songs related to the plant and animals you have introduced • Paint a giant sunflower • Observe an animal through a life cycle, e.g., butterfly, frog, goldfish • Grow plants, moon flowers • Paint flowers • Hatch frogs or butterflies • Draw conclusions about plant needs and begin to compare them to human needs after completing this simple investigation • Pick an ancient landmark or ecosystem like the pyramids and use it as a thematic unit: • The Great Wall of China • Ecosystem within U.S. • Construct a model of the Great Barrier Reef; watch a video on travel experiences such as	**K-ESS2-2** Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

	● Take a trip to the beach or lake as a closure lesson	swim with sharks, sing opera, and have a walk-about • Explore the continent of Africa and have our own African Safari complete with a homemade plane.	
● Recognize living and non-living things	● List living and nonliving elements in a picture or story and explain differences	● Explore classroom environment to find examples of living and non-living things ● Explore outdoor environment to search for and locate living and non-living things ● Peer teach with upper grades with model ecosystems	
● Differentiate between plant and animal life	● Create a list of differences between plants and animals ● Care for classroom plants and animals	● Set up aquariums and/or terrariums with a variety of plants and animals ● Observe plants and animals to determine differences between plant and animal life	**K-ESS3-1** Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

5. MATTER, ENERGY AND ORGANIZATION IN LIVING SYSTEMS: *Not introduced*

Grade PRE-K Science Curriculum
Earth and Space Science

1. COMPOSITION OF THE EARTH AND THE DYNAMICS THAT SHAPE IT

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Weather	● Use a SMART board or daily weather map to move symbols of the weather to create a daily report ● Ask questions about the clothes they wore to school today and if it matches the weather ● Draw a picture about one's favorite kind of weather and tell why ● Make a cloud in a jar, or rain in a jar ● As children collect leaves in their own backyard, they get to see how the chlorophyll has left the leaves, uncovering the yellow, orange and red colors underneath. This connects to a lesson in photosynthesis. ● A lesson on conserving energy and reduction of wind resistance.	● The children learn about the colors in the rainbow and how to mix primary colors to create new colors. ● Read *Living Color* by Steve Jenkins ● Listen to Here Comes Science — They Might Be Giants *ROYGBIV* ● Daily Weather report ● Draw pictures of the day's weather ● Distinguish weather from seasons and climate ● Dress a stuffed animal ● Talk about the children's favorite type of weather ● Change the clothes of our weatherman accordingly	**K-PS3-1** Make observations to determine the effect of sunlight on Earth's surface. **K-ESS2-1** Use and share observations of local weather conditions to describe patterns over time. **K-ESS3-2** Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.

● Seasons	● Go outside every day to learn about the changing temperatures ● Explain how rain and snow is created ● Discuss how animals react to the changing weather ● Draw squirrels, raccoons, bats, and owls decorate their homes ● Create a class book of the seasons ● The fall season is a chance to talk about harvest and nutrition apples and pumpkins and how they grow, (life cycle of a seed) from seed to harvested fruit	● Morning Meetings with season, daylight and weather reports ● Draw/Paint seasonal pictures ● Closure interdisciplinary lesson: Read and count *Apples Up On Top* by Dr. Seuss. Have a cooking segment making apple tarts, apple sauce, vegetable soup, introduce them to measurements of both dry and liquid ingredients ● Children learn some simple tools and techniques for wilderness survival to combat the change in weather	**1-ESS1-2** Make observations at different times of year to relate the amount of daylight to the time of year.

2. ORIGIN AND EVOLUTION OF THE UNIVERSE

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Days of week and months of year	● Read books and sing songs to learn the days of the week and months of the year	● Sing the days of week and months of the year ● Draw/Paint a picture of the sunrise, sunset, or moon or differentiate day and night explain day vs night	**1-ESS1-2** Make observations at different times of year to relate the amount of daylight to the time of year.

3. SPACE EXPLORATION

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● The solar system and our planet Earth	● Students simulate the solar system using light projector on the ceiling ● Children learn the phases of the moon, planets and their characteristics and stars ● Read books to begin study of the night sky ● Children engage in the idea of "carry in carry out," keeping our planet Earth clean and safe for generations to come ● Read *Down, Down, Down: A Journey to the Bottom of the Sea* by Steve Jenkins	● Display space posters ● Chart of events that happen during the day vs. night ● Space show and tell ● Read books about the moon, day and night ● Read a book about astronauts or label diagram ● Create a painted version of the Solar System. ● Eat space snacks ● The night sky leads into looking at nocturnal animals including raccoons, opossum, bats ● Grow and plant moon flowers that bloom at night ● Have a camp out (in the classroom)	**K-ESS3-3** Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

		● Take a walk around school and point out items that can harm the environment. ● Read story, *I Love the Earth* a lesson on conserving energy	

Grade K Science Curriculum Overview

Physical Science	Life Science	Earth and Space Science
1. **Structure of Atoms:** *Not introduced* 2. **Structure and Properties of Matter** ● Observable physical properties 3. **Chemical and Physical Changes** ● Changing properties of matter 4. **Motion and Forces** ● Push and pull 5. **Energy and their Interaction with Matter** ● Sound energy- sense of hearing	1. **The Cell:** *Not introduced* 2. **Reproduction and Heredity/Genetics:** ● Plants and animals resemble their parents 3. **Evolution:** ● The environment affects the survival of plants and animals ● Plants and animals have traits that help them survive 4. **Interdependence & Behavior of Organisms:** ● Different kinds of plants and animals are found in different habitats ● Recognize living and nonliving things ● Differentiate between plant and animal life 5. **Matter, Energy and Organization in Living Systems:** *Not introduced*	1. **Composition of the Earth and the Dynamics that Shape it:** ● Weather ● Seasons 2. **Origin and Evolution of the Universe:** ● Days of the week and the months of the year 3. **Space Exploration:** ● The solar system
Physical Science **Essential Questions and STEM Activity**	Life Science **Essential Questions and STEM Activity**	Earth and Space Science **Essential Questions and STEM Activity**
<u>K-PS2 Motion and Stability: Forces and Interactions</u> How can you change the motion of an object?	<u>K-LS1 From Molecules to Organisms: Structures and Processes</u> What patterns do plants and animals live out in order to survive?	<u>K-ESS2 Earth's Systems</u> What are some weather patterns we see on a daily, monthly, or seasonal basis? How do plants and animals change their environment?

STEM Activity K-PS2-2- Build a soda straw rocket using a straw, paper, and tape. <u>K-PS3 Energy</u> How does sunlight affect Earth's surface? STEM Activity K-PS3-1 Students test how much the sunlight warms up various surfaces (sand, rocks, dark colored paper, light colored paper, water). They touch all the surfaces at the beginning of the experiment, then touch the surfaces again after a period of time. The teacher can have a thermometer on hand.		<u>K-ESS3 Earth and Human Activity</u> How does a plant or animal's location relate to what they need to survive? STEM Activity K-ESS3-3- Create your own paper using single ply toilet paper, a mesh screen, water, a fork and a cake pan.

Grade K Science Curriculum
Physical Science Key Areas and Content Topics

1. STRUCTURE OF ATOMS: *Not introduced*

2. STRUCTURE AND PROPERTIES OF MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Observable physical properties	● Understand how objects are described based on their physical properties and how they are used ● Discuss the properties of matter after interacting with it, e.g., size, color, shape, texture, weight and flexibility ● Compare and contrast materials e.g., clay, wood, cloth, paper	● Draw pictures, copy science words, make a model ● Use the five senses to identify and list the properties of a type of matter ● Explain how some materials are sturdy and others are flexible ● Be able to classify a set of objects according to physical properties, e. g., sort blocks, plastic animals, materials with different textures, to size and/or color	**2-PS1-1** Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

3. CHEMICAL AND PHYSICAL CHANGES

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Changing the properties of matter	● Freeze, melt, or boil water ● Show pictures of frozen, melted, or gaseous substances ● Change the size ripping paper or shape of matter creating sculptures with model magic	● Show and Tell solid liquid gas ● Explain how the five senses: sight, hearing, touch, taste, and smell help teach us about physical properties ● Describe different “mystery matter”, e.g., cooking oil vs water, rock vs. sand, or helium filled balloon by their properties.	**2-PS1-3** Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

4. MOTION AND FORCES

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Push or Pull	● How to apply a push or pull to get the toy moving ● Design motion or speed demonstrations use toy planes, cars ● Compare and contrast push pull and motion vs no motion use dominoes	● Describe motion in terms of objects ● Observations motion ● Share ideas about motion and through drawings and interviews ● Pattern of pushes and pulls ● Model a change direction or talk about how you could increase the speed of a moving object	**K-PS2-1** Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. **K-PS2-2** Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

5. ENERGY AND ITS INTERACTION WITH MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Sound Energy: Sense of Hearing	● Each day begin with a mystery sound (from computer, tape recording, in a bag) ● Close eyes and listen to a sound. Record what students think they heard in a journal, then discuss. ● Strike a drum or xylophone and show how sound is produced	● Make cups and string phones ● Link with Music teacher to create simple instruments (oatmeal box drum, stretched rubber band, beads)	**1-PS4-1** Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

Grade K Science Curriculum
Life Science Key Areas and Content Topics

1. **THE CELL:** *Not introduced*

2. REPRODUCTION AND HEREDITY/GENETICS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Plants and animals resemble their parents	● Compare stuffed animals' adult vs. baby ● Show videos and read children's books that demonstrate variation among animals of the same species ● Bring in a bouquet of roses and have them point out what is different among the same	● Parent/offspring matchup (given pictures of animals, match up parent and offspring) ● Draw family pictures, or bring in photos, observe similarities and differences within a family	**K-LS1-1** Use observations to describe patterns of what plants and animals (including humans) need to survive.

3. EVOLUTION

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Environment affects the survival of plants and animals and resources for energy and growth	● Use a SMART Board to compare human and plant needs ● As a cooperative learning project, create a rain forest or other habitat ● Create a model of a plant ● Create a photo album of plants	● Make a list or drawing of what you eat and drink every day, or how to take care of a pet or plant ● Compare human and plant needs activity sheet use Venn Diagram or matching game ● Discuss basic needs required by plants and animals for growth ● Place a celery stalk in colored water to observe stem function	**K-LS1-1** Use observations to describe patterns of what plants and animals (including humans) need to survive.
● Plants and animals have traits that help them survive	● Study different species use magazines or *Wild Kratts* show ● Study fish in an aquarium and learn ways in which fish are adapted to live in water ● Use *Sound Safari* website on *PBS Kids.org* to identifying animal sounds ● View *Wild Kratts* on different animal types ● Create a list of differences between plants and animals ● Care for classroom plants and animals ● Read: *What Do You Do When Something Wants To Eat You?* by Steve Jenkins	● Role-play (students use masks to illustrate their understanding of the behavior and lifestyle of a variety of living organisms) ● Identify parts of a dinosaur body that were used for protection, movement and feeding ● Create an animal or plant that can survive under certain environmental conditions	**2-LS4-1** Make observations of plants and animals to compare the diversity of life in different habitats.

4. INTERDEPENDENCE & BEHAVIOR OF ORGANISMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Different kinds of plants and animals are found in different habitats	● Sort pictures of plants and animals according to the habitat in which they live ● Create a habitat for an imaginary animal ● Create an imaginary animal; draw and label its life cycle	● Identify and compare the various habitats in which animals and plants live ● Observe an animal through a life cycle, e.g., butterfly, frog, goldfish ● Collect postcards, brochures and pamphlets about plants and animals from other states ● Observe animal behavior in aquarium or zoo, farm ● Grow plants hatch frogs or butterflies ● Draw conclusions about plant needs and begin to compare them to human needs after completing this simple investigation	**2-LS4-1** Make observations of plants and animals to compare the diversity of life in different habitats.
● Recognize living and non-living things	● List living and nonliving elements in a picture or story and explain differences	● Explore classroom environment to find examples of living and non-living things ● Explore outdoor environment to search for and locate living and non-living things ● Peer teach with upper grades with model ecosystems	**3-LS1-1** Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

● Differentiate between plant and animal life	● View *Wild Kratts*, *Magic School Bus Returns* on different animal types ● Create a list of differences between plants and animals ● Care for classroom plants and animals	● Set up aquariums and/or terrariums with a variety of plants and animals ● Observe plants and animals to determine differences between plant and animal life	**K-ESS3-1** Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

5. MATTER, ENERGY AND ORGANIZATION IN LIVING SYSTEMS: *Not introduced*

Grade K Science Curriculum
Earth and Space Science

1. COMPOSITION OF THE EARTH AND THE DYNAMICS THAT SHAPE IT

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Weather	● Create symbols for temperature and precipitation and use them in a chart recording the weather for one week in school ● Draw a picture about one's favorite kind of weather and tell why ● Make a cloud in a jar, or rain in a jar	● Weather report ● Draw pictures of the day's weather ● Distinguish weather from seasons and climate ● Talk about the children's favorite type of weather ● Cloud sort puzzle or matching ● Build a *Lego* structure to protect a human from extreme weather next explain how it protects humans from weather	**K-PS3-1** Make observations to determine the effect of sunlight on Earth's surface. **K-ESS2-1** Use and share observations of local weather conditions to describe patterns over time. **K-ESS3-2** Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.
● Seasons	● Use sunrise and sunset chart talk about wake-up routine and how daylight changes with the season ● Create a class book of the seasons	● Morning Meetings with season, daylight and weather reports ● Dress a stuffed animal appropriately for a season ● Draw seasonal pictures	**1-ESS1-2** Make observations at different times of year to relate the amount of daylight to the time of year.

2. ORIGIN AND EVOLUTION OF THE UNIVERSE

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Days of week and months of year	● Draw a picture describing your favorite day and tell why	● Discuss activities that occur on a specific day in a specific month ● Observe and record the daily weather in a weather journal using drawings and/or pictures Demonstrate sun, moon and stars with visual aids (e.g., big books, posters, pictures)	**1-ESS1-2** Make observations at different times of year to relate the amount of daylight to the time of year.

3. SPACE EXPLORATION

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● The solar system	● View *Magic School Bus Returns* episodes on space ● Students simulate the solar system using objects created in art and demonstrate movement of the planets in an appropriate area (gymnasium, school field)	● Display space posters ● Participate in the National Space Day activities for elementary schools ● Chart events that happen during day vs. night ● Space show and tell ● Read books about moon, day and night ● Read a book about astronauts or label diagram ● Draw a picture of a planet ● Eat space snacks	**1-ESS1-1** Use observations of the sun, moon, and stars to describe patterns that can be predicted.

Grade 1 Science Curriculum Overview

Physical Science	Life Science	Earth and Space Science
1. **Structure of Atoms:** *Not introduced* 2. **Structure and Properties of Matter** ● Observable physical properties 3. **Chemical and Physical Changes** ● Changing properties of matter ● Water cycle 4. **Motion and Forces:** *Not introduced* 5. **Energy and their Interaction with Matter** ● Heat ● Light ● Sound ● Electricity	1. **The Cell:** *Not introduced* 2. **Reproduction and Heredity/Genetics** ● Plants and animals resemble their parents ● Individual differences exist in a species 3. **Evolution** ● The environment affects the survival of plants and animals ● Plants and animals have traits that help them survive in their environment 4. **Interdependence & Behavior of Organisms** ● Different kinds of plants and animals are found in different habitats ● Plants and animals in a given habitat depend on each other (community) ● Recognize living and nonliving things ● Differentiate between plant and animal life 5. **Matter, Energy and Organization in Living Systems** ● Plants and animals need certain resources for energy and growth ● Five senses	1. **Composition of the Earth and the Dynamics that Shape it** ● Weather ● Seasons 2. **Origin and Evolution of the Universe** ● Days of the week and the months of the year ● Objects in the day and night skies, sun, moon and stars 3. **Space Exploration** ● The solar system

Physical Science **Essential Questions and STEM Activity**	Life Science **Essential Questions and STEM Activity**	Earth and Space Science **Essential Questions and STEM Activity**
1-PS4 Waves and Their Applications in Technologies for Information Transfer What materials and actions create sound? How can materials change light? STEM Activity 1-PS4-1- Given a set of materials, create the different sounds and determine what happens to allow you to hear that sound.	1-LS1 From Molecules to Organisms: Structures and Processes How do plants and animals inspire designs that humans can use to solve problems? STEM Activity 1-LS1-1- Plan and design a solution to a human problem using plant or animal structures (a turtle shell looks like a helmet; thorns prevent a plant from being eaten.) STEM Activity 1-LS3 Heredity: Inheritance and Variation of Traits How are young plants and animals similar to, but also different from, their parents?	1-ESS1 Earth's Place in the Universe What patterns can we find in the sun, moon, and stars? What happens to the amount of daylight over the course of a year?

Grade 1 Science Curriculum
Physical Science Key Areas and Content Topics

1. STRUCTURE OF ATOMS: *Not introduced*

2. STRUCTURE AND PROPERTIES OF MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Observable physical properties	● Observe and measure the properties of matter, e.g., size, shape, weight, color, texture ● Look for similarities and differences	● Use the five senses to identify and list the properties of a type of matter. ● Create riddles about different types of matter. ● Be able to classify a set of objects according to physical properties, e.g., sort buttons made of various materials according to size and/or color	**2-PS1-1** Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

3. CHEMICAL AND PHYSICAL CHANGES

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Changing the properties of matter	● Cook or bake to demonstrate the changing of matter. Discuss the ways in which the matter changed. ● Explore the different results of combining water and salt, water and cornstarch, water and cooking oil, water and corn syrup. ● Change the size and shape of matter by molding clay	● Draw a picture and label the ingredients of a simple recipe and the results ● Give examples of the ways in which matter in the home is changed ● Describe different “mystery liquids”, e.g., corn syrup, cooking oil, water, vinegar, by their properties	**2-PS1-3** Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.
● The water cycle	● Collect pictures showing how water is used by plants and animals.	● Create and act out stories about the water cycle ● Create a classroom display showing uses of water by plants and animals.	**1-ESS1-1** Use observations of the sun, moon, and stars to describe patterns that can be predicted.

4. MOTION AND FORCES: *Not introduced*

5. ENERGY AND ITS INTERACTION WITH MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Heat	● Move from a lighted to a shaded area to observe and record temperature ● Teacher will demonstrate heat caused by friction (rubbing hands) ● Observe drops of food coloring in warm and cool water	● Create a collage showing different types of energy ● Graph the resulting temperature changes when moving from an area in the sun to an area in the shade ● Create a class book of different heat sources	**2-PS1-4** Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.
● Light	● Make shadows using different materials ● Use transparent, translucent, and opaque materials to demonstrate how light can travel through objects ● Use a mirror to show how light can be redirected	● Create a collage showing different types of energy ● Create a class book of different heat sources ● Draw a shadow ● Measure the length of a shadow as you change the angle of light ● Put a *Lego* man into a dark, enclosed box with two holes and have student “make the man appear” and “disappear” using a flashlight	**1-PS4-2** Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated. **1-PS4-3** Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.
● Sound	● Demonstrate how sound travels through vibration (use a rubber band, guitar strings) ● Strike a tuning fork and show how sound is produced ● Play music on a cell phone and feel the vibrations emitted by the speaker	● Create simple instruments (oatmeal box drum, stretched rubber band, beads) ● Make a coffee can telephone ● Use audio recorder their voice and see the audio visualization	**1-PS4-1** Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

	● A landline phone and cell phone transmit sound energy across large distances		
● Electricity	● Televisions transmit light and sound energy	● Appliances (TV, internet, radios) require electricity to turn on	**1-PS4-4** Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.

Grade 1 Science Curriculum
Life Science Key Areas and Content Topics

1. THE CELL: *Not introduced*

2. REPRODUCTION AND HEREDITY/GENETICS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Plants and animals resemble their parents	● Video about the zoo, go to a local zoo ● Read: *Are you my Mother?* (Discuss why parents react to offspring distress signals)	● Create a diorama with a report ● Create a book illustrating plant or animal characteristics ● Parent/offspring matchup (given pictures of animals, match up parent and offspring)	**1-LS1-2** Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive. **1-LS3-1** Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.
● Individual differences exist in a species	● Observe plants on a walking tour	● Create “picture safaris” of plants and animals from various habitats ● Create masks of plants and animals. Discuss where they live and how they get their food ● Compare pictures of plants and animals and describe characteristics that make them different from each other.	**1-LS3-1** Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

3. EVOLUTION

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Environment affects the survival of plants and animals	● Explore a variety of plants and animals in various environments	● Create a mural or diorama depicting one or more environments	
● Plants and animals have traits that help them survive in their environment	● Study responses of plants to environmental conditions ● Videos, guest speakers, visit library ● Study fish in an aquarium and learn ways in which fish are adapted to live in water ● Use *Sound Safari website* on *PBS Kids.org* to identifying animal sounds ● Parts of a plant: roots, stems, leaves, flowers and fruits	● Role-play (students use masks to illustrate their understanding of the behavior and lifestyle of a variety of living organisms) ● Identify parts of a dinosaur body that were used for protection, movement and feeding ● Create an animal or plant that can survive under certain environmental conditions	**1-LS1-1** Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.

4. INTERDEPENDENCE & BEHAVIOR OF ORGANISMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Different kinds of plants and animals are found in different habitats	● Identify and compare the various habitats in which animals and plants live ● Research an animal and its habitat ● Read book: *The Very Hungry Caterpillar* by Eric Carle ● Observe an animal through a life cycle, e.g., butterfly, frog, goldfish ● Collect postcards, brochures and pamphlets about plants and animals from other states ● Observe animal behavior in aquarium or zoo	● Sort pictures of plants and animals according to the habitat in which they live ● Create a habitat for an imaginary animal ● Create an imaginary animal; draw and label its life cycle ● Record observations of animal behavior in a picture log	**2-LS4-1** Make observations of plants and animals to compare the diversity of life in different habitats
● Plants and animals in a given habitat depend on each other (community)	● Observe ants in an ant farm to identify the division of labor (supplement with videos). ● Discover classroom environments that support plant life ● Research environments that support different kinds of plants and animals using videos	● Role-play: students act out each of the different jobs performed by bees in a beehive or ants in an ant farm ● Plant a variety of seeds in different soils and care for them ● Construct models of animals and plants in their environment ● Write a rebus story or news story about animals and plants in a supportive environment ● Create a variety of books: Class Book, Flip Book, Pop-Up Book	

● Recognize living and non-living things	● List living and nonliving elements in a picture or story and explain differences ● Create collages of living and non-living things ● Create a chart comparing and contrasting living and non-living things	● Explore classroom environment to find examples of living and non-living things ● Explore outdoor environment to search for and locate living and non-living things	
● Differentiate between plant and animal life	● Record observations of plants and animals in picture logs and journals. ● Create a list of differences between plants and animals ● Care for classroom plants and animals	● Set up aquariums and/or terrariums with a variety of plants and animals ● Observe plants and animals to determine differences between plant and animal life	

5. MATTER, ENERGY AND ORGANIZATION IN LIVING SYSTEMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Plants and animals need certain resources for energy and growth (food, water, light, air, home)	● As a cooperative learning project, create a rain forest or other habitat ● Diagram a plant with labels and explanation of its parts ● Create a model of a plant ● Create a photo album of plants	● Research basic needs required by plants and animals for growth ● Research the rain forest or other habitat (Internet, video, Interactive Encyclopedia) ● Place a celery stalk in colored water to observe stem function ● Explore root vegetables ● Investigate the need for a home using teddy bears and trying to fit them into different size boxes	**2-LS2-**1 Plan and conduct an investigation to determine if plants need sunlight and water to grow.
● Five Senses	● Identify the sense(s) used to recognize or describe an object ● Identify smells from unmarked containers ● Listen and identify sounds ● Create sense banners ● Create shape and color books ● Sort objects by color, size and shape ● Sort construction paper shapes into separate boxes ● Select shapes and create shape pictures ● Name foods that are lumpy, soft, hard, mushy, crispy, smooth, wet and dry ● Draw or cut out magazine pictures to create a collage of	● Collect objects in a touch box ● Collect nontoxic materials in containers for students ● Make a tape recording of common school sounds ● Identify musical instruments by sound ● Make musical instruments ● Collect pictures or photos that are similar, not identical ● Students look at pair of pictures and identify similarities and differences ● Collect rocks, shells, leaves to be sorted by students ● Make a repeating pattern with toothpicks, buttons, macaroni or pattern blocks. Students try	**4-LS1-2** Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

	sweet, salty, sour and bitter	to extend the pattern ● Observe changes in one tree in schoolyard several times each season, e.g., size, shape, color of buds, flowers, leaves, fruit, nuts, bark ● Record changes with photographs, drawings, charts ● Explore food textures, colors and shapes ● Read: *Bread and Jam for Frances* by Russell Hoban	

Grade 1 Science Curriculum
Earth and Space Science

1. COMPOSITION OF THE EARTH AND THE DYNAMICS THAT SHAPE IT

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Weather	● Create symbols for temperature and precipitation and use them in a chart recording the weather for one week in school ● Draw a picture about one's favorite kind of weather and tell why	● Record times for sunrise and sunset (Data from newspapers, television, Internet) ● Observe and record the daily weather in a weather journal using drawings and /or pictures ● Talk about the children's favorite type of weather	**K-PS3-1** Make observations to determine the effect of sunlight on Earth's surface. **K-ESS2-1** Use and share observations of local weather conditions to describe patterns over time. **K-ESS3-2** Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.
● Seasons	● Create a diorama depicting a season ● Use sunrise and sunset chart to search for patterns between length of day and the seasons ● Create a class book of the seasons ● Dress a stuffed animal appropriately for a season	● Mark the spot of a shadow on a sun clock every hour for one day (once in Fall, Winter, Spring), predict where it might be in the summer ● Discuss the effects of different seasons on what children wear and how it affects their play	**1-ESS1-2** Make observations at different times of year to relate the amount of daylight to the time of year.

2. ORIGIN AND EVOLUTION OF THE UNIVERSE

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Days of week and months of year	● Draw a picture describing your favorite day and tell why ● Use sunrise and sunset charts to search for patterns between length of day and seasons	● Discuss activities that occur on a specific day in a specific month ● Observe and record the daily weather in a weather journal using drawings and/or pictures Demonstrate sun, moon and stars with visual aids (e.g., big books, posters, pictures) ● Work in teams to trace partner shadows ● Draw a picture of the sun's position in the sky at that time	**1-ESS1-2** Make observations at different times of year to relate the amount of daylight to the time of year.
● Objects in the day and night skies, sun, moon and stars	● Identify pictures and diagrams of sun, moon and stars ● Explain the difference between night and day ● Draw pictures of objects seen in the day sky and night sky	● Create a sun clock using a flowerpot ● Demonstrate sun, moon and stars with visual aids (e.g., big books, posters, pictures) ● Work in teams to trace partner shadows ● Draw a picture of the sun's position in the sky at that time ● Daily moon log for one month in a science journal ● Create a discussion on how changes in daylight throughout the year can affect their play time and wake up routine.	**1-ESS1-1** Use observations of the sun, moon, and stars to describe patterns that can be predicted. **1-ESS1-2** Make observations at different times of year to relate the amount of daylight to the time of year.

3. SPACE EXPLORATION

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● The solar system	● Construct a model of the solar system ● Students simulate the solar system using objects created in art and demonstrate movement of the planets in an appropriate area (gymnasium, school field)	● Read *My Place in Space* by Robin Hirst ● Display space posters ● Participate in the National Space Day activities for elementary schools ● Poster or model of a the planet and planet reports	

Grade 2 Science Curriculum Overview

Key Areas and Content Topics

Physical Science	*Life Science*	*Earth and Space Science*
1. Structure of Atoms: *Not introduced* **2. Structure and Properties of Matter** ● Observable physical properties **3. Chemical and Physical Changes** ● Changing properties of matter **4. Motion and Forces** ● Effect of force ● Direction/location and gravity **5. Energy and their Interaction with Matter** ● Magnetism	**1. The Cell:** *Not introduced* **2. Reproduction and Heredity/Genetics:** *Expanded upon in 3rd grade* **3. Evolution:** *Expanded upon in 3rd grade* **4. Interdependence and Behavior of Organisms** ● Different kinds of plants and animals are found in different habitats ● Plants and animals in a given habitat depend on each other (community) ● Pollination **5. Matter, Energy and Organization in Living Systems** ● Plants and animals need certain resources for energy and growth	**1. Composition of the Earth and the Dynamics that Shape it** ● Composition of the Earth ● Changing landforms ● Weather and climate **2. Origin and Evolution of the Universe** *Not covered* **3. Space Exploration** ● The solar system ● Space travel

Physical Science **Essential Questions and STEM Activity**	Life Science **Essential Questions and STEM Activity**	Earth and Space Science **Essential Questions and STEM Activity**
2-PS1 Matter and Its Interactions How can scientists classify materials? STEM Activity 2-PS1-1- Determine a way or ways to classify a set of materials based on your observations of them.	2-LS2 Ecosystems: Interactions, Energy, and Dynamics What happens to plants that don't receive water or sunlight? How do animals help plants? STEM Activity 2-LS2-1- Design how to make a plant grow taller than your classmates' plants. 2-LS4 Biological Evolution: Unity and Diversity How different are plants and animals in different locations?	2-ESS1 Earth's Place in the Universe What are processes on Earth that occur slowly and processes on Earth that occur quickly? 2-ESS2 Earth's Systems How can we model the movement of water in Earth's landscapes?

Grade 2 Science Curriculum

Physical Science

1. STRUCTURE OF THE ATOM: *not introduced*

2. STRUCTURE AND PROPERTIES OF MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Observable physical properties	● Observe and measure the properties of matter, e.g., size, shape, weight, color, texture, hardness, ● Look for similarities and differences materials ● Maker's corner present students with miscellaneous materials have them construct something new	● Use the five senses to identify and list the properties of a type of matter ● What would you use? Water spills-would you use a paper towel or aluminum foil? Which is most absorbent- sponge or paper towel? ● Create riddles about different types of matter ● Be able to classify a set of objects according to physical properties, e. g., sort buttons made of various materials according to size and/or color	**2-PS1-1** Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. **2-PS1-2** Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose. **2-PS1-3** Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

3. CHEMICAL AND PHYSICAL CHANGES

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Changing the properties of matter	● Cook or bake to demonstrate the changing of matter. Discuss the ways in which the matter changed ● Explore the different results of combining water and salt, water and cornstarch, water and cooking oil, water and corn syrup ● Use ice melting to demonstrate change of state, then refreeze ● Show video of paper burning show it is not reversible ● Change the size and shape of matter by molding clay	● Draw a picture and label the ingredients of a simple recipe and the results ● Give examples of the ways in which matter in the home is changed ● Describe different “mystery liquids”, e.g., corn syrup, cooking oil, water, vinegar, by their properties	**2-PS1-4** Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

4. MOTION AND FORCES

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Effect of force	● Predict how the application of force will affect something.	● Use a push or a pull to demonstrate the way a force can change the position of an object (Push and pull a variety of wheeled toys with varying degrees of force). Discuss what happens	**3-PS2-1** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

● Direction/location and gravity	● Group task: observe and explain how things move ● Describe the location of an object by giving clues to its position ● Observe falling objects off a table	● Roll different objects down inclines of various degrees ● Bounce and throw balls ● Push and pull a variety of wheeled toys with varying degrees of force ● Use playground equipment, e.g., swing, to experiment with different amounts and directions of forces ● Read Aesop's fable, *The Tortoise and the Hare* ● Play a game in which one student chooses an object in the classroom and gives clues as to its location	

5. ENERGY AND ITS INTERACTION WITH MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Magnetism	● Explore various types of magnets	● Identify a magnet from a variety of metal objects ● Classify objects as magnetic or non-magnetic and explain why they are different	**3-PS2-3** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

Grade 2 Science Curriculum
Life Science Key Areas and Content Topics

1. THE CELL: *Not introduced*

2. REPRODUCTION AND HEREDITY/GENETICS: *Expanded upon in 3rd grade*

3. EVOLUTION: *Expanded upon in 3rd grade*

4. INTERDEPENDENCE AND BEHAVIOR OF ORGANISMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Different kinds of plants and animals are found in different habitats	● Identify and compare the various habitats in which animals and plants live ● Research an animal and its habitat ● Observe an animal through a life cycle, e.g., butterfly, frog, goldfish ● Collect postcards, brochures and pamphlets about plants and animals from other states ● Observe ants in an ant farm to identify the division of labor (supplement with videos) ● Observe animal behavior in aquarium or zoo	● Sort pictures of plants and animals according to the habitat in which they live ● Create a habitat for an imaginary animal ● Create an imaginary animal; draw and label its life cycle ● Role-play: students act out each of the different jobs performed by bees in a beehive or ants in an ant farm ● Record observations of animal behavior in a picture log	**2-LS4-1** Make observations of plants and animals to compare the diversity of life in different habitats.
● Plants and animals in a given habitat depend on each other (community)	● Discuss different types of plants and animals that live together in the ocean ● Discuss different types of plants and animals that live	● Draw an environment where a bird would live ● Name a plant and animal that depends on each other's existence	

	together in the jungle	● Identify an example of a reptile, a bird, a fish, a mammal, an amphibian, an insect ● Write a story or poem of the relationship between different types of plants and animals	
● Pollination	● Students can simulate pollination while using crushed colored chalk with Q-tips and “pollinate” construction paper “flowers”. ● Discover classroom environments that support plant life ● Research environments that support different kinds of plants and animals using videos.	● Create a flow chart plant pollination ● Given a set of miscellaneous objects, design a simple tool or model to move “rice” (seeds) from your table to the “flower” plate ● Plant a variety of seeds in different soils and care for plants ● Construct models of animals and plants in their environment ● Write a rebus story or news story about animals and plants in a supportive environment ● Create a variety of books: Class Book, Flip Book, Pop-Up Book	**2-LS2-2** Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.

5. MATTER, ENERGY AND ORGANIZATION IN LIVING SYSTEMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Plants and animals need certain resources for energy and growth (food, water, light, air, home)	● Research basic needs required by plants for growth ● Research the rain forest or other habitat ● Compare plant in shade vs plant in sunlight ● Compare plant given water each day to a plant that is not watered	● Diagram a plant with labels and explanation of its parts (review) ● Create a photo album of plants ● Draw or create a model of a plant with what is necessary for its survival	**2-LS2-1** Plan and conduct an investigation to determine if plants need sunlight and water to grow.

Grade 2 Science Curriculum
Earth and Space Science

1. COMPOSITION OF THE EARTH AND THE DYNAMICS THAT SHAPE IT

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Composition of the earth	● Explore different types of soil ● Experiment to discover which kind of material is best to grow plants ● Collect rocks, observe and classify them by their appearance ● Show pictures of the following: Hill, Valley, Mountain, Plain, Island, Ocean, River, Lake, Pond, Desert, Volcano	● Identify sand, soil, clay ● Create a classroom rock museum ● Identify rocks as being composed of several different substances ● Using clay or rocks, model different landforms, and use blue clay for water	**2-ESS2-2** Develop a model to represent the shapes and kinds of land and bodies of water in an area. **2-ESS2-3** Obtain information to identify where water is found on Earth and that it can be solid or liquid.
● Changing landforms	● Observe the effects of weathering ● Investigate erosion by pouring water into trays of soil at different elevations	● Predict the results of water running down a slope ● Given a shoebox with sand, create a design to prevent wind (blowing air) from changing the landscape ● Present students with different images of environmental weathering scenarios which they have to classify	**2-ESS2-1** Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

● Seasons	● Mark the spot of a shadow on a sun clock every hour for one day (once in Fall, Winter, Spring), predict where it might be in the summer ● Discuss the effects of different seasons on what children wear	● Create a diorama depicting a season ● Use sunrise and sunset chart to search for patterns between length of day and the seasons ● Create a class book of the seasons	**3-ESS2-1** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
● Weather and climate	● Make a flipbook of different climates around the world and how those climates change over seasons ● Show pictures of the impact of thunderstorms, tornadoes, hurricanes, floods ● Show pictures and discuss how scientists and engineers design buildings to withstand weather-hazards	● Students will play a matching climate game to pair pictures to a particular climate ● Design a structure to withstand a particular weather-hazard	**3-ESS2-2** Obtain and combine information to describe climates in different regions of the world. **3-ESS3-1** Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

3. SPACE EXPLORATION

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● The solar system	● Read *My Place in Space* by Robin Hirst ● Display space posters ● Participate in the National Space Day activities for elementary schools	● Construct a model of the solar system ● Students simulate the solar system using objects created in art and demonstrate movement of the planets in an appropriate area (gymnasium, school field)	**5-ESS1-2** Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. **MS-ESS1-3** Analyze and interpret data to determine scale properties of objects in the solar system.
● Space travel	● Research astronauts and rockets ● Explore the differences between a rocket and an airplane ● Write to a NASA Astronaut and ask him/her questions about his/her work	● Draw a picture of a rocket and describe each part of the rocket ● Pack a suitcase for space travel. List what should be included and explain why certain items have been selected and are important	

Grade 3 Science Curriculum Overview
Key Areas and Content Topics

Physical Science	*Life Science*	*Earth and Space Science*
1. Structure of Atoms: *Not introduced* **2. Structure and Properties of Matter:** *Expanded upon in 5th grade* **3. Chemical and Physical Changes:** *Expanded upon in 5th grade* **4. Motion and Forces** ● Effect of force **5. Energy and its Interaction with Matter** ● Magnetism ● Electricity	**1. The Cell:** *Not introduced* **2. Reproduction and Heredity/Genetics:** ● Traits are inherited from parents ● Reproduction as a life process ● Stages of life **3. Evolution** ● Animals and plants are classified by their traits ● Internal and external structures of plants and animals ● Adaptation to environmental changes enables plants and animals to survive ● Fossils are evidence of change **4. Interdependence and Behavior of Organisms** ● Organisms compete for things they need to survive ● Changes in habitats affect survival of their inhabitants ● Survival tactics of plants and animals ● Humans can impact habitats in positive or negative ways **5. Matter, Energy and Organization in Living Systems:** *Expanded upon in 4th grade*	**1. Composition of the Earth and the Dynamics that Shape it** ● Composition of the earth ● Changing landforms ● Weather **2. Origin and Evolution of the Universe:** *Expanded upon in 4th grade* **3. Space Exploration:** *Expanded upon in 4th grade*

Physical Science **Essential Questions and STEM Activity**	Life Science **Essential Questions and STEM Activity**	Earth and Space Science **Essential Questions and STEM Activity**
3-PS2 Motion and Stability: Forces and Interactions How can forces affect the motion of objects? STEM Activity 3-PS2-1- Build a tower as tall as possible that also holds a tennis ball without falling over. Sample materials- cups, straws, popsicle sticks, tape. STEM Activity 3-PS2-1- Create a personal floatation device (PFD) for a can of soup or other dense object so it floats in water.	3-LS1 From Molecules to Organisms: Structures and Processes What are patterns that all organisms share? What are patterns that makes organisms different? 3-LS2 Ecosystems: Interactions, Energy, and Dynamics Why do animals live in groups? 3-LS3 Heredity: Inheritance and Variation of Traits Where do animals get their traits, and what can affect these traits? 3-LS4 Biological Evolution: Unity and Diversity What can fossils tell us about where and how ancient organisms lived? How do differences in organisms help them survive?	3-ESS2 Earth's Systems What patterns can be found in weather and climate? 3-ESS3 Earth and Human Activity What can humans do to limit the effect of natural disasters?

Grade 3 Science Curriculum
Physical Science

1. STRUCTURE OF ATOMS: *Not introduced*

2. STRUCTURE AND PROPERTIES OF MATTER: *Expanded upon in 5th grade*

3. CHEMICAL AND PHYSICAL CHANGES: *Expanded upon in 5th grade*

4. MOTION AND FORCES

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Effect of force	● Introduce and explore the work of Rube Goldberg (Pulitzer Prize winning cartoonist) ● Demonstrate how pushing down on a lever can move an object ● Experiment with dropping a ball from different heights: graph the results. ● Use a video clip of a child swinging (or build a pendulum) to help explain patterns of movement	● Design a Rube Goldberg device ● Give examples of the effects of force used in the home. ● Given a ball, a book, a desk, etc., students should explain how they can apply force to move an object, and how to demonstrate that gravity is a force that pulls objects downward. ● Using a yarn attached to a ball (e.g., a Wiffle ball), students should be able to predict what will happen if you pull the ball up and let go (that it will swing)	**3-PS2-1** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. **3-PS2-2** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

5. ENERGY AND ITS INTERACTIONS WITH MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Magnetism	● Make a compass using a needle in a cork and a dish of water	● Predict if a magnet will attract an object ● Use unlabeled magnets and determine their polarity ● Magic Movement- move an object using magnetism (ex. Magnets, paper clips)	**3-PS2-3** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. **3-PS2-4** Define a simple design problem that can be solved by applying scientific ideas about magnets
● Electricity	● Demonstrate static electricity by rubbing a balloon on your hair and holding it near paper, pith balls on a string, or tinsel, bending water.	● Magic Movement- move an object using static electricity (ex. balloon, plastic easter eggs, paper, tissues, thin cloth)	**3-PS2-3** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

Grade 3 Science Curriculum
Life Science

1. THE CELL: *Not introduced*

2. REPRODUCTION AND HEREDITY/GENETICS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Traits are inherited from parents	● Observe color of different types of flowers (carnations, tulips, pansies) and other physical characteristics ● Observe physical characteristics of animals ● Look at picture of young animals next to their parents and observe similarities (inherited characteristics) that are different from other species ● Research inherited traits in own family ● Read *A Fish Out of Water* by Helen Palmer Geisel to help demonstrate the effects of overfeeding pets and how diet can change your body	● Create a list or chart of plant and animal inherited traits ● Create a way to distinguish different types of animals from each other (e.g., Number of limbs, floppy vs pointy ears, hair vs fur) ● Create a way to distinguish different types of plants (e.g., type/size/shape of leaves, number of petals, trunk vs stem) ● Write a "How To" Guide for how to best care for a pet ● Conduct an experiment of three plants, one not watered, one watered a normal amount, and one watered an excessive amount	**3-LS3-1** Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. **3-LS3-2** Use evidence to support the explanation that traits can be influenced by the environment.
● Reproduction as a life process	● Plant seeds and observe growth ● Read library books relating to the life cycle of a plant ● Lima Bean dissection	● Describe life cycle of a flowering plant ● Journal: Measure height of growing plants; write descriptions of how the plants change each day; draw plant growth ● Draw life cycle of an animal	**3-LS1-1** Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

• Stages of life	• Circle of life- all animals have parents • Stages of a flowering plant- seed, sprout/seedling, adult plant produces fruits with seeds • Observe growth of seedlings to maturity • Research: video, computer program, transparencies of animal growing to adulthood • Observe the stages of a mealworm (Egg, Larva, Pupa, Adult) to butterflies	• Create a chart of plant growth • Draw a sequence of stages that show an example of a complete life cycle • Sequence sets of cards that depict the stages in the life cycle of three different organisms and talk about the similarities and differences in the sequences • Create Sprout Houses with lima bean seeds and track or graph the growth of lima bean	**3-LS1-1** Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death cycles but all have in common birth, growth, reproduction, and death.

3. EVOLUTION

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
• Animals and plants are classified by their traits	• Observe differences in color, shape and size of shells • Field trip for purpose of collecting living objects: drawing, photographing and/or videotaping • Observe patterns of veins in different leaves • Research using tree guidebook • Create leaf rubbings • View nature programs, e.g., local network, cable TV • Investigate ways scientists classify living things • Observe animal likenesses and differences (observe some with	• Sort shells into categories • Sort collections into categories of Plants, Animals, Unknown • Identify trees using leaf pictures • Create habitats using plant and animal pictures • Create a chart of animal characteristics • Create a Six Kingdoms Chart (examples and characteristics)	**2-LS4-1** Make observations of plants and animals to compare the diversity of life in different habitats.

	hand lens) ● Record animal likenesses and differences ● Research the Six Kingdoms (Animal, Plant, Fungi, Protist, Eubacteria, Archaebacteria)		
● Internal and external structures of plants and animals	● Investigate differences in vertebrates ● Research vertebrates using video, software program ● Compare and contrast mammals, birds, fish, reptiles, amphibians ● Define warm blooded and cold-blooded vertebrates ● Identify parts of a plant on a diagram ● Look at the skeletal structure of an animal and describe how certain bones and muscles allow the animal to move	● Create a list of vertebrates and their characteristics, e.g., horses, hippos, cats, birds, snakes, lizards, frogs, fish ● Construct a habitat for a vertebrate, e.g., ocean, river, forest, mountain, desert ● Create paper bag book ● Create a dictionary of terms used to classify animals ● Research one animal, write a report (include: cover, title page, document, illustrations, game(s), test questions and references) ● Design a game incorporating information about an animal ● Create an imaginary vertebrate and write a poem or story	**4-LS1-1** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
● Adaptation to environmental changes enables plants and animals to survive	● Explore adaptations for survival ● Hang posters of different habitats in classroom	● Written and/or oral presentation explaining reasons organisms live in a specific habitat ● Students design a creature that would be able to survive on a described unknown planet ● Remove a resource (water, sunlight) to observe survival of plants ● Given a set of three plants OR	**3-LS4-2** Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages. in surviving, finding mates, and reproducing.

		three animals in a particular environment, explain which animal would be most likely to survive in that environment (polar bear would survive in the arctic because of its fur, camel would survive in the desert)	**3-LS4-3** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. **3-LS4-4** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
● Fossils are evidence of change	● Research fossils in encyclopedia/computer science program ● Describe fossils from photographs ● Observe fossils of organisms that no longer exist ● Create a model of a fossil imprint ● Discuss animals that have gone extinct	● Create a chart listing fossil names and period when they lived ● Using a model of a fossil, determine the type of animal that existed in its particular environment	**3-LS4-1** Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.

4. INTERDEPENDENCE AND BEHAVIOR OF ORGANISMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Organisms compete for things they need to survive	● Research survival characteristics of organisms ● Observe microhabitat, e.g., local field, pond, well-traveled pathway ● Record microhabitat observations in words and pictures	● Debate the reasons certain species are extinct ● Written report describing characteristics and quantities of animal and plant life in microhabitat	**3-LS4-1** Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago. **3-LS4-2** Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. **3-LS4-3** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
● Changes in habitats affect survival of their inhabitants	● Field trip to different environments, e.g., local streams, ponds, rivers, wildlife areas, school grounds (STEM activity) ● Explore animal adaptations using a variety of materials	● Create map of habitat ● Create a journal to record observations of ecosystems ● Construct an environment that will sustain life within the classroom setting (STEM activity)	**3-LS4-4** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants

		● Debate issues related to factors that limit or encourage growth of populations ● Use data obtained to analyze the impact of environmental changes on living organism ● Create original field guide	and animals that live there may change.
● Survival tactics of plants and animals	● Explore innate and learned behaviors ● Observe pet training videos and compare and contrast pet behaviors ● Discuss sacredness of life and care of pets ● Observe life in an aquarium ● Investigate plant behavior ● Visit farm, pet shop or other areas to observe animals caring for their young	● Research a tamed and a wild animal and do a written and oral report on each ● Construct a collage using clippings from magazines, etc., to illustrate caring for young by mammals and birds ● Safety in Numbers- explain how a type of animal lives in groups and how it helps their collective survival (obtain food, defend themselves, find shelter, etc.)	**3-LS2-1** Construct an argument that some animals form groups that help members survive.
● Humans can impact habitats in positive or negative ways	● Research different habitats, e.g., desert, rainforest, tundra ● Read Genesis Creation story	● Identify characteristics of a habitat ● Do a written report, poster, bulletin-board display of impact of humans on the environment ● Contrast Genesis Creation story with our treatment of the Earth ● Design bumper sticker for Earth Day	**3-LS4-4** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change **3-ESS3-1** Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

5. Matter, Energy and Organization in Living Systems: *Expanded upon in 4th grade*

Earth and Space Science

1. COMPOSITION OF EARTH AND THE DYNAMICS THAT SHAPE IT

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Composition of the earth	● Use familiar objects to illustrate the location of the crust, mantle and core of the earth (STEM activity) ● Melt chocolate and marshmallows and allow to cool and harden to illustrate the effects of heating and cooling on rock and the formation of lava	● Describe an imaginary journey to the center of the earth	**4-ESS2-2** Analyze and interpret data from maps to describe patterns of Earth's features.
● Changing landforms	● Explore the concept of Pangaea ● Use different colors of clay to make models showing the effects of the movement of land ● Explore the concept of plate tectonics ● Research the effects of movement of the plates	● Use construction paper to tear out the shapes of the continents and fit them together ● Give an oral report about a volcanic eruption (e.g., Mt. St. Helen, Vesuvius)	**2-ESS1-1** Use information from several sources to provide evidence that Earth events can occur quickly or slowly.
● Weather	● Identify and observe the elements of weather ● Devise simple instruments to measure weather. Record data in graph and/or table form (STEM activity) ● Analyze the data gathered on weather to find patterns and relationships within the data ● Draw a weather map indicating different weather patterns (STEM activity)	● Write a story that describes your favorite kind of weather ● Jigsaw Passport- Teacher picks four countries, each student gets one country and creates a passport depicting its climate. Then, each student shares and fills in the other countries from classmates ● Keep a class weather book ● Track and graph daily temperature, wind speed, and amount of precipitation	**3-ESS2-1** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. **3-ESS2-2** Obtain and combine information to describe climates in different regions of the world.

		• Flood Barrier Design Challenge- Design and make a flood barrier for a doghouse using given materials, and analyze its success (STEM activity) • Tornado-Proof: Design and make a structure that would be wind resistant (use a fan or hairdryer as the wind), and analyze its success (STEM activity)	**3-ESS3-1** Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

2. ORIGIN AND EVOLUTION OF THE UNIVERSE
Expanded upon in 5th grade

3. SPACE EXPLORATION:
Expanded upon in 5th grade

Grade 4 Science Curriculum
Key Areas and Content Topics
Overview

Physical Science	Life Science	Earth Science
1. Structure of Atoms: *Introduced 5th grade* **2. Structure and Properties of Matter** ● Observable physical properties **3. Chemical and Physical Changes** *Expanded upon in 5th grade* **4. Motion and Forces:** *Expanded upon in 5th grade* **5. Energy and their Interaction with Matter** ● Solar energy ● Heat, light ● Sound energy ● Waves ● Transfer of energy	**1. The Cell:** *Introduced 5th grade* **2. Reproduction and Heredity/Genetics:** *Expanded upon in 5th grade* **3. Evolution:** *Expanded upon in 5th grade* **4. Interdependence & Behavior of Organisms** ● Animals and plant behaviors are influenced by internal and external factors (cues) **5. Matter, Energy and Organization in Living Systems** ● The sun as the source of energy for living things through the producers (photosynthesis) ● Transfer of energy (food) is essential to all living organisms ● Organization of simple food chains and food webs ● Body systems	**1. Composition of the Earth and the Dynamics that Shape it:** ● Composition of the earth ● Weathering and erosion ● Changing landforms ● Renewable and nonrenewable resources **2. Origin and Evolution of the Universe:** *Expanded upon in 5th grade* **3. Space Exploration:** *Expanded upon in 5th grade*

Physical Science **Essential Questions and STEM Activity**	Life Science **Essential Questions and STEM Activity**	Earth and Space Science **Essential Questions and STEM Activity**
4-PS3 Energy How can energy be transferred? STEM Activity 4-PS3-4- Design a solar cooker. STEM Activity 4-PS3-4- Design a watermill or wind turbine. 4-PS4 Waves and Their Applications in Technologies for Information Transfer How can waves show patterns in nature? STEM Activity 4-PS4-2 Design a way to bounce light off of objects to hit a target.	4-LS1 From Molecules to Organisms: Structures and Processes How do internal and external structures in plants and animals affect their function?	4-ESS1 Earth's Place in the Universe Why do landscapes change over time? 4-ESS2 Earth's Systems Why are maps of Earth’s features useful for humans? STEM Activity 4-ESS2-1- Design a way to limit erosion on a miniature environment. 4-ESS3 Earth and Human Activity What designs do humans create to limit the effect of natural disasters? STEM Activity 4-ESS3-2. Create a water filter that can clean particles from teacher-prepared "dirty water."

Grade 4 Science Curriculum
Physical Science

1. STRUCTURE OF ATOMS: *Introduced in 5th grade*

2. STRUCTURE AND PROPERTIES OF MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES\	NGSS OUTCOME
● Observable physical properties	● Observe and measure the properties of matter, e.g., size, shape, weight, color, texture (STEM activity) ● Look for similarities and differences	● Use the five senses to identify and list the properties of a type of matter ● Create riddles about different types of matter ● Be able to classify a set of objects according to physical properties, e. g., sort buttons made of various materials according to size and/or color	

3. CHEMICAL AND PHYSICAL CHANGES: *Expanded upon in 5th grade*

4. MOTION AND FORCES: *Expanded upon in 5th grade*

5. ENERGY AND ITS INTERACTIONS WITH MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Solar energy	● Research solar energy ● Investigate the greenhouse effect	● Design a device to measure solar energy ● Plan a self-contained terrarium	
● Heat, light	● Observe heat generated by a light bulb (STEM activity) ● Explore reflection and refraction through use of mirrors and prisms (STEM activity)	● Prepare an oral or graphic explanation of the production of heat from some other form of energy ● Demonstrate conduction and convection ● Design and construct a periscope (STEM activity)	**4-PS3-2** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. **4-PS3-3** Ask questions and predict outcomes about the changes in energy that occur when objects collide.
● Sound energy	● Fill bottles with varying levels of water and play a tune by blowing into them. Discuss why the pitches are different ● Build a string telephone	● Predict the pitch of lengths of elastic bands from highest to lowest ● Demonstrate and explain the solution to designing a string telephone that will work around a corner	**4-PS3-4** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
● Waves	● Using a slinky or long rope demonstrate transverse waves and compressional waves. Change speed/frequency of waves and observe the change in wavelength, wave height and amplitude (STEM activity) ● Use a tub of water and drop	● Use a tuning fork to demonstrate how waves can cause objects (ex. water) to move ● Use yarn, rope, or a slinky to create a wave, and explain how you can create a larger wave ● Students can play “Simon says”	**4-PS4-1** Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. **4-PS4-2** Develop a

	small rock, then larger rock. Compare size of wave. Place rubber duck midway in tub, make waves again, and observe that the duck was not displaced. ● Show a video showing how echolocation works	and demonstrate waves by jumping with different amplitudes, and to model a short and long ● Explain how sound waves can be used to gain information (sonar used to determine depth of ocean)	model to describe that light reflecting from objects and entering the eye allows objects to be seen. **4-PS4-3** Generate and compare multiple solutions that use patterns to transfer information.
● Transfer of Energy	● Colliding marbles- demonstrate how moving marbles transfers to stationary marbles (STEM activity) ● Moving hand on table creates a noise ● Playing music on a computer shows transfer of energy from electric to sound energy ● Using Dropper poppers, dropping from different heights will cause them to bounce at different levels ● Create a rollercoaster to show transfer of energy from potential to kinetic (STEM activity)	● Put a thermometer in a jar of water, put on the windowsill with sun exposure, and record the temperature over the course of a day ● Given a set of materials, name three ways that energy can be transferred ● Create a circuit using wires, a lightbulb, and a battery (or use Little Bits) ● Given a set of materials, create a model of kinetic, potential, and sound energy (STEM activity)	**4-PS3-1** Use evidence to construct an explanation relating the speed of an object to the energy of that object. **4-PS3-2** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. **4-PS3-3** Ask questions and predict outcomes about the changes in energy that occur when objects collide. **4-PS3-4** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Grade 4 Science Curriculum

Life Science

1. The Cell: *Introduced 5th grade*

2. Reproduction and Heredity/Genetics: *Expanded upon in 5th grade*

3. Evolution: *Expanded upon in 5th grade*

4. INTERDEPENDENCE AND BEHAVIOR OF ORGANISMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Animals and plant behaviors are influenced by internal and external factors (cues)	● Read *What do you do with a tail like this?* by Robin Page to foster discussion on how particular body parts help animals survive ● Explore inborn and learned behaviors ● Investigate plant behavior ● Visit farm, pet shop or other areas to observe animals caring for their young ● Discuss different ways animals interact ● Watch PBS Learning- *Wild Kratts* episode *Night Primates and Eye Adaptations*	● *Why are my eyes so big?* Explain why animals have particular features ● Research a tamed and a wild animal and do a written and oral report on each ● Construct a collage using clippings from magazines, etc., to illustrate caring for young by mammals and birds ● Design an animal that can adapt/fit in to a particular biome (STEM activity)	**4-LS1-1** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. **4-LS1-2** Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

5. MATTER, ENERGY AND ORGANIZATION IN LIVING SYSTEMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● The sun as the source of energy for living things through the producers (photosynthesis)	● Use digital media to illustrate the photosynthesis process (STEM activity) ● Experiment by removing one variable of photosynthesis and record the results, e.g., place a plant in the dark	● Dramatize steps in photosynthesis	
● Transfer of energy (food) is essential to all living organisms	● Place celery in food coloring to observe water transport through stem	● Diagram and/or write about transport of materials in plants and animals	
● Organization of simple food chains and food webs	● Research: food chains/webs: magazine, software program ● Research producers, consumers, and decomposers	● Create a food web or food chain and label the producers, consumers, and decomposers	
● Body Systems	● Read: *The Magic School Bus Inside the Human Body*, Joanna Cole ● Find pulse by counting pulse beats while sitting quietly, after jumping jacks (STEM activity) ● Read: *The Visual Dictionary of the Human Body*, Dortling Kindersley ● Create a chart of pulse rates	● Identify the major parts of body systems: Nervous, Circulatory, Digestive, Respiratory ● Trace an outline of two students' bodies on a large sheet of paper and indicate where various parts are located ● Create a list of some activities that cause heart rate to increase or decrease ● Record and compare pulse rates ● Orally describe or trace the path of food through the digestive system	

Grade 4 Science Curriculum

Earth and Space Science

1. COMPOSITION OF EARTH AND THE DYNAMICS THAT SHAPE IT

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Composition of the earth	● Use familiar objects to illustrate the location of the crust, mantle and core of the earth ● Melt chocolate and marshmallows and allow to cool and harden to illustrate the effects of heating and cooling on rock and the formation of lava ● Students can observe topographic maps and analyze the changes in elevation ● Make topographic maps on the student desks with shaving cream (STEM activity)	● Describe an imaginary journey to the center of the earth	**4-ESS1-1** Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. **4-ESS2-2** Analyze and interpret data from maps to describe patterns of Earth's features.
● Weathering and erosion	● Students will place pieces of colored chalk into a Tupperware, seal and then shake to simulate weathering.	● Use stacked sugar cubes and slowly add water with a pipette, as it sits on an inclined cafeteria tray. Apply water and then uncover and see how the "rocks" eroded. Explain using evidence how and why erosion occurred (STEM activity)	**4-ESS2-1** Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

● Changing landforms	● Explore the theory of plate tectonics and Pangaea ● Use different colors of clay to make models showing the effects of the movement of land ● Research the effects of movement of the plates	● Use construction paper to tear out the shapes of the continents and fit them together ● Give an oral report about a volcanic eruption (Mt. St. Helen, Vesuvius)	
● Renewable and nonrenewable resources	● Discuss different ways New Jersey generates electricity (solar, nuclear, wind, fossil fuels) ● Discuss the human impact of nonrenewable resources on the environment	● Write a letter to your local Congressman explaining your point of view on renewable and nonrenewable energy ● Debate your side of a renewable energy plan ● Debate whether your church or school should invest in solar panels for the roof	**4-ESS3-1** Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. **4-ESS3-2** Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

2. ORIGIN AND EVOLUTION OF THE UNIVERSE: *Expanded upon in 5th grade*

3. SPACE EXPLORATION: *Expanded upon in 5th grade*

Grade 5 Science Curriculum Overview

Physical Science	Life Science	Earth Science
1. **Structure of Atoms** ● Parts of the atom 2. **Structure and Properties of Matter** 3. **Chemical and Physical Changes** ● Changes in state ● Water cycle 4. **Motion and Forces** ● Effect of force ● Gravity ● Work and energy ● Newton's Laws and simple machines 5. **Energy and their Interaction with Matter** ● Solar energy ● Heat, light	**1. The Cell** ● Cell as basic unit of life ● Cell parts and functions (nucleus, cell membrane, cytoplasm) **2. Reproduction and Heredity/Genetics** ● Traits are inherited from parents ● Reproduction as a life process ● Stages of life 3. **Evolution** ● Animals and plants are classified by their traits ● Adaptation to environmental changes enables plants and animals to survive 4. **Interdependence of Organisms** ● Organisms compete for things they need to survive ● Ecosystem observations ● Humans can impact habitats in positive or negative ways **5. Matter, Energy and Organization in Living Systems** ● The sun as the source of energy for living things through the producers (photosynthesis) ● Transfer of energy (food) is essential to all living organisms ● Body systems	**1. Composition of the Earth and the Dynamics that Shape it** ● Composition of the earth ● Changing landforms ● Human impact on earth **2. Origin and Evolution of the Universe:** ● The solar system ● The movements of the earth ● The phases of the moon ● The causes of the seasons and eclipses ● Stars and constellations 3. **Space Exploration:** ● Exploring the solar system ● The history of space exploration ● Unmanned exploration ● Adapting to an environment different from that of the earth

Physical Science **Essential Questions and STEM Activity**	Life Science **Essential Questions and STEM Activity**	Earth and Space Science **Essential Questions and STEM Activity**
5-PS1 Matter and Its Interactions How can scientists classify or identify one material from another? 5-PS2 Motion and Stability: Forces and Interactions How do forces like gravity affect objects? STEM Activity 5-PS2-1- Use straws, paper clips, and yarn to build a mobile that can hold several paper clips on different ends while maintaining balance. The straws should hang at different levels so that they can freely rotate such that paper clips from other levels don't get caught in each other. STEM Activity 5-PS2-1- Use a plastic bag, a LEGO man, and yarn to create a parachute that allows the LEGO man to hit the ground as slowly as possible with the materials given. 5-PS3 Energy What would happen to life on Earth if there were no sun, and why?	5-LS1 From Molecules to Organisms: Structures and Processes How do plants get what they need to grow and survive? 5-LS2 Ecosystems: Interactions, Energy, and Dynamics Why do organisms depend on each other for survival?	5-ESS2 Earth's Systems How do rocks, water, air, and life all impact each other? 5-ESS3 Earth and Human Activity What effects do humans have on their environment? STEM Activity 5-ESS3-1- Design and build an oil boom to contain and prevent the spread of oil spills. (Sample materials include a plastic bin of water, dark-colored cooking oil, cotton balls, straws, sponge, dishwashing liquid)

Grade 5 Science Curriculum
Physical Science

1. STRUCTURE OF ATOMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Parts of an atom	● Research the structure of atoms using videos and software ● Make models of atoms using everyday objects ● Use paper clips, LEGOs to model the structure of a molecule	● Draw and label a diagram of an atom ● Express some common compounds using chemical symbols, e.g., water as H_2O ● Role play the interaction of atomic particles	**5-PS1-1** Develop a model to describe that matter is made of particles too small to be seen.

2. STRUCTURE AND PROPERTIES OF MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Observable physical properties	● Observe and measure the properties of matter, e.g., size, shape, weight, color, texture ● Look for similarities and differences ● Explore with Ooblek and determine whether it is a solid, liquid or both	● Use the five senses to identify and list the properties of a type of matter ● Create riddles about different types of matter ● Classify a set of objects according to physical properties, e. g., sort buttons made of various materials according to size or color	**5-PS1-3** Make observations and measurements to identify materials based on their properties.

3. CHEMICAL AND PHYSICAL CHANGES

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Changes in state of matter	● Observe evaporation and condensation and discuss what happens in each process ● Record in a journal the results of timing the evaporation of different liquids, e.g., alcohol, water, vinegar, soda	● Give examples of physical and chemical changes and explain why they are different	**5-PS1-2** Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. **5-PS1-4** Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
● Water cycle	● Observe water and other moisture in the environment and record the findings ● Record in a log, the amount of water used by a student's family for one week	● Design a system to purify water ● Create a graph of the amount of water used for different purposes by the class	**5-ESS2-2** Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

4. MOTION AND FORCES

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Effect of force	● Introduce and explore the work of Rube Goldberg (Pulitzer Prize winning cartoonist) ● Demonstrate how pushing down on a lever can move an object ● Experiment with dropping a ball from different heights: graph the results	● Design a “Rube Goldberg” device (STEM activity) ● Give examples of the effects of force used in the home	
● Gravity	● Video showing how a person can jump higher on the moon than on earth	● Create a parachute using plastic bags to safely land a lifesaver, and explain how this demonstrates the force of gravity (STEM activity)	**5-PS2-**1 Support an argument that the gravitational force exerted by Earth on objects is directed down.
● Work and energy	● Demonstrate how an electric pencil sharpener converts electrical energy to mechanical energy ● Explore how changing the amount of friction or gravity affects the force necessary to do work, e.g., compare the amount of force needed to push an object up an inclined plane of various heights	● Describe how potential and kinetic energy differ ● Design a flowchart showing how energy can be converted to work ● Design and demonstrate an experiment to show the effect of either friction or gravity on the amount of force necessary to do work (STEM activity)	**5-PS2-1** Support an argument that the gravitational force exerted by Earth on objects is directed down.

● Newton's Laws and Simple Machines	● Locate examples of simple machines in the classroom and on the playground ● Explore different combinations of simple machines, e.g., manual pencil sharpener	● Bring in and demonstrate examples of simple machines ● Label the simple machines in a bicycle	**MS-PS2-5** Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. **MS-PS2-1** Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

5. ENERGY AND ITS INTERACTIONS WITH MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Solar energy	● Research solar energy ● Investigate the greenhouse effect ● Hydroponics to demonstrate that soil is not necessary for photosynthesis	● Design a device to measure solar energy ● Plan a self-contained terrarium ● Create a flowchart or diagram showing the transfer of energy	**5-PS3-1** Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. **5-LS1-1** Support an argument that plants get the materials they need for growth chiefly from air and water.
● Heat, light	● Observe heat generated by a light bulb ● Explore reflection and refraction through use of mirrors and prisms	● Prepare an oral or graphic explanation of the production of heat from some other form of energy ● Demonstrate conduction and convection ● Design and construct a periscope	**4-PS3-4** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Grade 5 Science Curriculum
Life Science

1. THE CELL

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Cell as the basic unit of life	● Observe cells with microscope, micro-viewer, magnifying glasses ● Compare animal and plant cells ● Display diagram of cell in classroom ● Draw observations of cells ● Research: Video, computer program, Internet, encyclopedia, Virtual Cell models online	● Present written and/or oral report on the difference between plant cells and animal cells ● Describe the function of the parts that are different	**MS-LS1-1** Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
• Cell parts and functions (nucleus, cell membrane, cytoplasm)	● Look at cells under a microscope ● Compare a plant and animal cells for similarities and differences	● Construct models of different cells ● Play a matching game to match the function of an organelle to its name	**MS-LS1-2** Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.

2. REPRODUCTION AND HEREDITY/GENETICS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Traits are inherited from parents	● Observe color of flowers and number of limbs of an animal ● Research inherited characteristics of humans ● Research inherited traits in own family	● Create a list or chart of plant and animal inherited traits	**3-LS3-1** Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. **MS-LS1-5** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
● Reproduction as a life process	● Plant seeds and observe growth ● Visit zoo, vet or watch a video of an animal giving birth ● Read library books relating to the life cycle of a plant	● Describe life cycle of a plant ● Journal: Measure height of growing plants; write descriptions of how the plants change each day; draw plant growth ● Draw life cycle of an animal △	**MS-LS1-4** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

● Stages of life	● Observe growth of seedlings to maturity ● Research: video, computer program, transparencies of animal growing to adulthood	● Create a chart of plant growth ● Draw a sequence of stages that show an example of a complete life cycle ● Sequence sets of cards that depict the stages in the life cycle of three different organisms and talk about the similarities and differences in the sequences	**3-LS1-1** Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

3. EVOLUTION

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Animals and plants are classified by their traits	● Explain taxonomic ranks: kingdom, phylum or division, class, order, family, genus, species ● Observe differences in color, shape and size of shells ● Field trip for purpose of collecting living objects: drawing, photographing and/or videotaping ● Observe patterns of veins in different leaves ● Research using tree guidebook ● Create leaf rubbings ● View nature programs, e.g., *local network, cable TV* ● Investigate ways scientists classify living things ● Observe animal likenesses and differences (observe some with hand lens) ● Record animal likenesses and differences ● Research the Five Kingdoms (*Animal, Plant, Fungi, Protist and Monera*)	● Define Taxonomy ● Create a Five Kingdoms Chart (examples and characteristics) ● Sort shells into categories ● Categorize Taxonomic ranks of animals: sort collections into categories of Plants, Animals ● Identify trees using leaf pictures ● Create habitats using plant and animal pictures ● Create a chart of animal vs plant characteristics	

● Adaptation to environmental changes enables plants and animals to survive	● Explore adaptations for survival ● Hang posters of different habitats in classroom ● Research fossils in encyclopedia/computer science program ● Describe fossils from photographs	● Written and/or oral presentation explaining reasons organisms live in a specific habitat ● Students design a creature that would be able to survive on a described unknown planet ● Create a chart listing fossil names and period when lived ● Create a model of a fossil imprint	**MS-LS4-6** Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

4. INTERDEPENDENCE OF ORGANISMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
▪ Organisms compete for things they need to survive	● Research survival characteristics of organisms ● Observe microhabitat, e.g., *local field, pond, well-traveled pathway*. ● Record microhabitat observations in words and pictures.	● Debate the reasons certain species are extinct. ● Written report describing characteristics and quantities of animal and plant life in microhabitat.	
● Ecosystem Observations	● Field trip to different environments, e.g., *local streams, ponds, rivers, beachfront, estuary, wildlife areas, or the school grounds*.	● Create map of habitat. ● Journal: observations of ecosystems. ● Construct an environment that will sustain life within the classroom setting. ● Debate issues related to factors that limit or encourage growth of populations. ● Create original field guide	**5-LS2-1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
● Humans can impact habitats in positive or negative ways	● Research different habitats, e.g., *desert, rainforest, tundra*. ● Read Genesis Creation story.	● Identify characteristics of a habitat. ● Do a written report, poster, bulletin-board display of impact of humans on the environment. ● Contrast Genesis Creation story with our treatment of the Earth. ● Design bumper sticker for Earth Day.	**5-ESS3-1** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

5. MATTER, ENERGY AND ORGANIZATION IN LIVING SYSTEMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● The sun as the source of energy for living things through the producers (photosynthesis)	● Use overhead and diagrams to illustrate the photosynthesis process. ● Experiment by removing one variable of photosynthesis and record the results, e.g., *place a plant in the dark*	● Dramatize steps in photosynthesis.	**5-LS1-1** Support an argument that plants get the materials they need for growth chiefly from air and water.
● Transfer of energy (food) is essential to all living organisms	● Place celery in food coloring to observe water transport through stem ● Feed the class pet (fish) or mealworms over time to demonstrate that the matter in the food went into the organism to make it larger ● Put earthworms and newspaper into a closed container with holes to show that earthworms turn food into energy for themselves ● Discuss roles of herbivores, carnivores, omnivores ● Observe changes in diversity and the size of populations in terrarium or aquarium. ● Explore decomposition using a real pumpkin ● Research: food chains/webs: encyclopedia, magazine, software program.	● Diagram and/or write about transport of materials in plants and animals. ● Conduct an experiment in which one plant receives fertilizer and the other does not to show how matter can be incorporated into plants and help them grow ● Construct model of a food chain/food web. ● Written and/or oral report about food chain or food web that includes producers, consumers, and decomposers ● Journal: Write results of observations of terrarium or aquarium.	**5-LS2-1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

● Body Systems	● Use Virtual Reality and Internet animations to tour the Human Body ● Read: *The Magic School Bus Inside the Human Body*, Joanna Cole. ● Find pulse; count pulse beats while sitting quietly; do ten jumping jacks; count pulse beats; count pulse beats ● Read: *The Visual Dictionary of the Human Body*, Dortling Kindersley ● Create a chart of pulse rates ● Heart Model	● Identify the major parts of body systems: Nervous, Circulatory, Digestive, Respiratory and Reproductive ● Create a list of some activities that cause heart rate to increase. ● Record and compare pulse rates. ● Orally trace the path of food through the digestive system ● Model heart with pool noodles to construct a human heart, use yarn to track the flow of blood	

Grade 5 Science Curriculum
Earth and Space Science

1. COMPOSITION OF EARTH AND THE DYNAMICS THAT SHAPE IT

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Composition of the earth	● Use familiar objects to illustrate the location of the crust, mantle and core of the earth. ● Melt chocolate and marshmallows and allow to cool and harden to illustrate the effects of heating and cooling on rock and the formation of lava.	● Describe an imaginary journey to the center of the earth.	**5-ESS2-1** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
● Changing landforms	● Explore the concept of Pangea. ● Use different colors of clay to make models showing the effects of the movement of land ● Explore the concept of plate tectonics. ● Research the effects of movement of the plates.	● Use construction paper to tear out the shapes of the continents and fit them together. ● Give an oral report about a volcanic eruption (Mt. St. Helen, Vesuvius)	**5-ESS2-2** Describe and graph the amounts of saltwater and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.
● Human Impact on the Earth	● Research how humans can protect Earth's resources and environments by using alternative energy sources.	● Create Earth Day Posters incorporating the three R's (reduce, reuse, recycle)	**5-ESS3-1** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

2. ORIGIN AND EVOLUTION OF THE UNIVERSE

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● The solar system	● Create a mnemonic device to help remember the order of the planets ● Research the planets using books, videos and the Internet ● Compare and contrast the planets with respect to size, composition, atmosphere and distance from the sun	● Draw and label a diagram of the planets in the solar system ● Prepare and present orally a travel brochure advertising one planet • ● Create an alien that could survive the conditions on a planet other than Earth	
● The movements of the earth	● Use a globe to model the movements of revolution and rotation.	● Define and demonstrate rotation and revolution.	**5-ESS1-2** Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.
● The phases of the moon	● Observe and record the moon over a period of time and record the phases of the moon observed	● Draw and label one complete cycle of the moon.	**MS-ESS1-1** Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

● The causes of the seasons and eclipses	● Demonstrate eclipses through the use of models of the earth, moon and sun. ● Demonstrate the difference between direct and indirect rays of the sun using globes and flashlights	● Summarize in written form how the motion of the earth and its relative position affect our climate and produce lunar and solar eclipses.	**5-ESS1-2** Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.
● Stars and Constellations	● Create a powerpoint, brochure for a planetarium, reports on the life cycle of a star, the shape of galaxies, names of constellations. ● Compare and Contrast the difference between the modern astronomer's definition of a constellation and the ancient definition.	● Use Diagrams and Tables to interpret and predict constellations during different times of year based on location	**5-ESS1-1** Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from the Earth.

3. SPACE EXPLORATION

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Exploring the solar system	● Research humans' basic needs for survival on another plant. ● Research space flight. ● Research the characteristics of Mars (library, Internet)	● Develop a plan for building a community on Mars ● Integrate Social Studies to include the type of government for Mars.	**5-ESS1-1** Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.

● The history of space exploration	● Research the development of space travels in the 20th century, using the library and the Internet. ● Write letters to NASA to request information. ● Read *From the Earth to the Moon* by Jules Verne.	● Give on oral presentation about first spacecraft used to be launched into space. ● Create and label a timeline of space explorers.	N/A
● Unmanned exploration	● Research the exploration of Mars landscape including distance, location. ● Field Trip to Buehler Space Center for Mars, and Moon Missions	● Report on one major probe that has explored a planet. ● Design a transport device to land safely on the Moon Ex. Egg drop Challenge ● Relate their probe to historical missions to space	N/A
● Adapting to an environment different from that of Earth	● Brainstorm the requirements of living and working in space. ● Research the elements that are necessary to support life and how these can be duplicated in space. ● Compare on a chart living condition in space with living condition in own town/city.	● Work in cooperative groups to experience a simulation of an exploratory trip in space. ● Assign student to be responsible for all aspects of designing and furnishing a space station. ● Keep a journal of activities that might occur. ● Write a description of an imaginary exploration of the surface of a planet	N/A

Grade 6-7-8 Science Curriculum Overview

This course of study can either be a year-long course or divided among grades 6, 7, and 8

Physical Science	Life Science	Earth Science
1. Structure of Atoms ● Discovery of atomic structure and theory; Periodic Table ● Types of chemical bonding ● Nuclear fission and fusion **2. Structure and Properties of Matter** ● Physical and chemical properties of matter ● States of matter and kinetic molecular theory ● Boiling point, melting point, and solubility ● Cohesion and adhesion ● Variables affecting atmospheric pressure ● Qualitative description of gases: gas laws **3. Chemical and Physical Changes** ● Law of Conservation of Mass ● Chemical reactions in society ● Physical changes, chemical changes ● Boiling point, melting point, solubility ● Chemical reactions – exothermic, endothermic ● Variables affecting pressure ● Atmospheric pressure, cohesion, adhesion ● Kinetic molecular theory ● Qualitative description of gases: gas laws	**1. The Cell** ● Structure and function of cell organelles: mitochondria, chromosomes, ribosome, lysosome, golgi bodies, vacuoles, cytoplasm, cell wall, cell membrane, chloroplast, endoplasmic reticulum ● Cell growth and mitosis ● Cellular Respiration and movement into/out of the cell ● Photosynthesis **2. Reproduction and Heredity/Genetics:** ● DNA structure ● Reproduction life cycles and patterns ● Environmental and genetic factors influence the growth of organisms **3. Evolution:** ● Geologic time and fossil evidence of change ● Natural selection and Evolution ● Genetic engineering ● Graphing population changes	**1. Composition of the Earth and the Dynamics that Shape it** • Structure of the earth system • Geosphere, plate tectonics and its effect on the geosphere, hydrosphere, history of the Earth, glacial deposits, fossils • Weather systems and climate • Geochemical and geophysical cycles • Effects of catastrophic events • Human impacts on the Earth • Global climate change **2. Origin and Evolution of the Universe** • The Universe Formation Stars, “Big Bang Theory” • Components of the solar system • Observations of movement of objects • Sun-Earth-Moon interactions • Seasons • Effect of gravity on celestial bodies

4. Motion and Forces ● Universal Law of Gravitation ● Speed – velocity, acceleration, deceleration, terminal velocity, momentum ● Equilibrium, friction ● Newton's Laws of Motion ● Electricity, magnetism ● Simple machines and mechanical advantage ● Bernoulli's Principle **5. Energy and its Interaction with Matter** • Law of Conservation of Energy • Forms of energy and heat transfer • Characteristics of waves	**4. Interdependence and Behavior of Organisms** ● Behavior and structure affects function ● Extinction of species ● Symbiosis (commensalism, mutualism, parasitism) ● Food chains/food webs ● Ecosystems/relationships within biomes ● Human impact on the environment **5. Matter, Energy and Organization in Living Systems** ● Levels of organization and body systems ● Classification of kingdoms	**3. Space Exploration** • Early space exploration, history of the space program, discovery about past explorations, internet explorations/downloading of resources, virtual reality on space

Grade 6-7-8 Science Curriculum

Outcomes by end of 8th Grade		
Physical Science ● Compare and contrast the parts of an atom ● Understand that all matter is made up of atoms ● Define what an element is and identify the types of elements in a periodic table ● Demonstrate that matter is composed of moving particles ● Describe the physical and chemical properties of matter ● Compare a physical and chemical change ● Demonstrate the different kinds of chemical reactions ● Use the metric system in measurements and calculations ● Understand mathematical relationships among variables ● Model Newton's Laws of Motion ● Demonstrate how inertia affects the motion of an object and how the force of friction acts to retard motion ● Describe how simple machines work ● Describe the Law of Conservation of Energy	***Life Science*** ● Understand the cell as a fundamental unit of life ● Understand the processes of photosynthesis and plant and animal reproduction ● Explore reproduction and life cycles in an ecosystem ● Investigate natural adaptation in fossil records ● Demonstrate an understanding of the nine body systems and their functions ● Explore adaptive behaviors and behavioral response to stimuli ● Investigate the basic principles of Mendelian Inheritance ● Be able to classify living things/organisms	***Earth And Space Science*** ● Demonstrate an understanding of the earth system ● Understand the components of the solar system ● Demonstrate an understanding of the origin, evolution and structure of the universe ● Explain how forces change the earth's surface ● Understand the variety of weather systems that affect the earth ● Explain how fossils are related to evolution • Explain the importance of space exploration to our future

Physical Science **Essential Questions and STEM Activity**	Life Science **Essential Questions and STEM Activity**	Earth and Space Science **Essential Questions and STEM Activity**
MS-PS1 Matter and its Interactions What does matter look like on a very small scale? What happens to matter during chemical reactions?	MS-LS1 From Molecules to Organisms: Structures and Processes How are humans dependent on cells? How do your genes and your environment affect how you look and function? STEM Activity MS-LS1-1- Set up a laboratory observation experiment where students have to come up with criteria for determining whether something is a living thing or not a living thing. Examples include dry yeast in sugar water, seltzer water, sand, rocks	MS-ESS1 Earth's Place in the Universe How do objects in space create cyclical patterns for those on Earth? What is the evidence that scientists have to estimate the age of Earth and to explain the processes that have occurred on Earth? STEM Activity MS-ESS1-1-Use a flashlight to model sunlight and balloons to model a scaled size of Earth and Earth’s Moon, and use a flashlight to demonstrate the phases of the moon and daytime/nighttime STEM Activity MS-ESS1-2. Use a simulation program to model how changes in masses of objects in space affect whether they will orbit each other STEM Activity MS-ESS1-3. Reconstruct Pangaea using the continents that currently exist

MS-PS2 Motion and Stability: Forces and Interactions How do gravitational, electric, and magnetic forces affect the motion of objects? STEM Activity MS-PS2-2- Create a car using a balloon to demonstrate balanced versus unbalanced forces	MS-LS2 Ecosystems: Interactions, Energy, and Dynamics How is matter cycled between Earth and organisms? Why is biodiversity important for the survival of organisms?	MS-ESS2 Earth's Systems Why does water move throughout Earth? Why is weather always changing? What can we learn about Earth by looking at mountains, seafloors, continents, and physical features on Earth? STEM Activity MS-ESS2-1- Students determine and experiment with ways to use crayons to model the Rock Cycle STEM Activity MS-ESS2-5- Use weather maps (Temperature, Pressure, Dew points, Station plots and fronts) to determine how moving air masses affect weather in a particular location
MS-PS3 Energy How is energy conserved in most circumstances? STEM Activity MS-PS3-3- Design a solar oven to create s'mores in the shortest amount of time possible. (Cardboard boxes, aluminum foil, plastic wrap)	MS -LS3 Heredity: Inheritance and Variation of Traits Why can DNA change from one generation of organisms to the next?	MS -ESS3 Earth and Human Activity How can humans predict future natural catastrophes? How do humans positively and negatively impact the environment? STEM Activity MS-ESS3-3- Design a rain garden and explain how it works

<u>MS-PS4 Waves and their Applications in Technologies for Information Transfer</u> How do light and mechanical waves travel through matter? How does the structure of a wave affect its properties?	<u>MS -LS4 Biological Evolution: Unity and Diversity</u> Why have organisms changed over the last few billion years? STEM Activity MS-LS4-4- Simulate natural selection by using different types of candy (Skittles, marshmallows) and different types of utensils (forks, spoons, knives) to determine which “organisms” (candy) survives each “predator” (utensils)	

Physical Science Grades 6-8 Overview

This course of study can either be a year-long course or divided among grades 6, 7, and 8

Physical Science	
1. Structure of Atoms ● Discovery of atomic structure and theory; Periodic Table ● Types of chemical bonding ● Nuclear fission and fusion **3. Structure and Properties of Matter** ● Physical and chemical properties of matter ● States of matter and kinetic molecular theory ● Boiling point, melting point, and solubility ● Cohesion and adhesion ● Variables affecting atmospheric pressure ● Qualitative description of gases: gas laws **4. Chemical and Physical Changes** ● Law of Conservation of Mass ● Chemical reactions in society ● Physical changes, chemical changes ● Boiling point, melting point, solubility ● Chemical reactions – exothermic, endothermic ● Variables affecting pressure ● Atmospheric pressure, cohesion, adhesion ● Kinetic molecular theory ● Qualitative description of gases: gas laws	**5. Motion and Forces** ● Universal Law of Gravitation ● Speed – velocity, acceleration, deceleration, terminal velocity, momentum ● Equilibrium, friction ● Newton's Laws of Motion ● Electricity, magnetism ● Simple machines and mechanical advantage ● Bernoulli's Principle **6. Energy and its Interaction with Matter** • Law of Conservation of Energy • Forms of energy and heat transfer • Characteristics of waves

Grade 6-7-8 Science Curriculum

1. STRUCTURE OF ATOMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Discovery of atomic structure and theory; The Periodic Table	● Describe matter in terms of atoms that are joined to form molecules that can be found in any one of the four states of matter ● Explain the structure of an atom in terms of protons, neutrons, and electrons ● Present the history of the discovery of the parts of the atom. Explain how the technology of the time aided scientists ● Discuss why Marie Curie's research was harmful to her. ● In their discovery, e.g. 1911 – Ernest Rutherford, aided by newly discovered x-rays found that electrons surround the atom's core, the nucleus	● State today's modern atomic theory and explain how it differs from the earlier theories ● Research time periods in which major advances regarding knowledge of the atom took place. What world events took place during the same time periods? ● Hypothesize how the modern atomic theory might change as scientists make new observations ● Present a play to younger students about the accomplishments of Pierre and Marie Curie. The whole class can be involved in writing a scientifically accurate skit and in gathering simple props and costumes	**MS-PS1-1** Develop models to describe the atomic composition of simple molecules and extended structures.

● Types of chemical bonds	● Explain the difference between covalent, ionic, and metallic bonding	● Be able to determine whether a compound has covalent or ionic bonding based on the atomic structure of the compound	
● Nuclear fission and fusion	● Explain how bonds, which hold the protons and neutrons of an atom's nucleus together, contain energy	● Research the Manhattan Project and present an oral report. On a poster board, distinguish between fission and fusion, using colorful diagrams. Display posters in the classroom	

2. STRUCTURE AND PROPERTIES OF MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Physical and chemical properties of matter	● Play the "Matter Guessing Game". Call on individual students to describe the physical properties of a mystery object while the other students try to guess the object being described ● Show how to calculate the density of a block ● Show to use a scale and a graduated cylinder to find mass and volume ● Use an image of a boat floating to help explain buoyancy ● Show an example using Archimedes principle	● Using a variety of objects, describe and measure the physical properties of mass, volume, and density, using proper lab equipment. On a sheet of paper, rank them in order from least to greatest for each physical property. ● Find the density of a candy bar using a ruler and scale ● Find the mass and volume of various classroom items. ● When given a diagram of various objects in water, determine whether the object is buoyant	

● States of matter and kinetic molecular theory	● Provide the class with O*obleck* (a colloid mixture of cornstarch and water). Allow the class to handle the substance and record their observations. List the physical properties discovered while examining the "oobleck". Read *Bartholomew and the Oobleck* by Dr. Seuss ● Show kinetic energy in the molecules of all forms of matter	● Define the term matter and identify its three states ● Explain why water is important and how it is helpful and harmful in each of its three states ● Draw a diagram to model what molecules of water look like as a solid, liquid or gas ● Create a song with a tempo that correlates to the thermal energy of atoms ● Explain how room freshener, cooking smells, or perfume spray spread	**MS-PS1-4** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
● Boiling point, melting point, solubility	● Explain melting point and boiling point (the two fixed temperatures at which every substance changes state). Explain the role of heat when matter changes from one state to another. ● Explain how the boiling point of a liquid is affected by pressure	● Dissolve salt in water. Explain what type of change occurs. Can the salt and water be separated? If yes, how and if not, why not? ● Explain why M&M chocolate candies melt in your mouth and not in your hand	
● Cohesion, adhesion	● Explain how to read a graduated cylinder when you see a meniscus (adhesion)	● How many drops of water on water can you put on a penny?	

● Variables affecting pressure	● Discuss any changes in atmospheric pressure students may have experienced when riding in an elevator of a skyscraper, flying in an airplane, or ascending a mountain. Explain why the discomfort was felt	● Explain the changes in tire pressure when riding a bike or driving a car on a hot day ● Using a labeled diagram, explain the difference in air pressure at sea level and on a mountaintop ● Make a bottle barometer and observe changes in atmospheric pressure over a seven-day period. Keep a daily log of observations	
● Qualitative description of gases: gas laws	● Explain how the Gas Laws are physical laws that describe the behavior of a gas when pressure, volume, or temperature is changed ● Using examples, show how liquids and gases exert their pressure in all directions and how pressure from liquids increases with depth ● Have students investigate the measurement of water pressure ● Demonstrate the “egg in the bottle” experiment. Have students observe and offer explanations as to how an egg can go magically into a bottle that has a mouth smaller than the egg	● Define the relationship between volume and pressure of gas ● Explain how hot air balloonists can calculate the amount of air necessary for a lift ● Explain why astronauts wear special pressurized suits in space	

3. CHEMICAL AND PHYSICAL CHANGES

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Law of Conservation of Mass	● Put vinegar and baking soda in a sealed bag, and in an unsealed bag. Measure the mass before and after each ● Burn a sugar cube in aluminum foil in a beaker on top of a hot plate to demonstrate how heat can cause chemical changes as part of a chemical reaction. Production of an odor signals a chemical reaction. Flammability is a chemical property ● Burn a small piece of steel wool in a test tube (put a match in a test tube then a small piece of steel wool) or put the steel wool into vinegar to demonstrate oxidation	● Give students three bags of substances to determine whether a chemical reaction has occurred, and how they know (baking soda and vinegar [YES], sugar and water [NO])	**MS-PS1-2** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **MS-PS1-5** Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
● Chemical reactions in society	● Natural or artificial? Students predict whether materials were created by nature or by humans ● Discovery of penicillin from mold ● Fossil fuels to make plastic ● Bioplastics are made from substances like corn starch and can be biodegradable ● Gasoline for cars sometimes has ethanol created from corn ● Palm oil is used in cosmetics. This contributes to deforestation and thus more carbon dioxide	● Research different types of packing material and how their creation and disposal impacts the environment ● Pick a synthetic fiber and research how it is made, how it affects the environment, and alternatives people can use synthetic fabrics such as: polyester, acrylic, nylon, Spandex and acetate are all made from nonrenewable fossil fuels	**MS-PS1-3** Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

● Physical changes, chemical changes	● Explain through the use of demonstrations and examples, how the identifying properties of a substance remain unchanged in a physical change. (Melt ice cubes, tear paper, carve shapes using a bar of soap) ● Prepare cake batter and bake in an oven at school. Discuss how this process includes both physical and chemical changes ● Gather pictures of chemical changes, e.g., weathering of the Statue of Liberty, a fireworks show, rusty metal, a burned house. Discuss why these are chemical changes	● Explain how the faces on Mt. Rushmore are a product of physical change ● List a variety of physical changes. Discuss whether or not it is possible to bring the matter back to the form it was before the physical changes occurred ● Make a video or posters in which physical and chemical changes are demonstrated or illustrated. Draw the pictures or gather them from magazines Clearly label all examples	
● Chemical reactions exothermic, endothermic	● Explain exothermic and endothermic reactions using examples of each. Explain the meaning of “exo-” and “endo-” ● Invite a photographer to explain how pictures are developed: the chemical processes involved, chemicals used, and the chemical changes that occur ● Discuss whether or not it is possible for matter to return to the form it was in before the chemical change occurred ● Explain why melting ice cubes is a good example of an endothermic reaction and why freezing water is a good example of an exothermic	● Using ice cubes, explain changes in mass and volume when the state of matter changes ● Explain what happens to atoms and molecules when a chemical reaction occurs ● Describe different kinds of chemical reactions and how some chemical changes can be prevented ● Identify several everyday chemical reactions and explain how substances are changed into one or more new substances ● Describe and explain four kinds of evidence for chemical reactions ● Write a paragraph to explain the changes that occur when you bake	● **MS-PS1-6** Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

	reaction and discuss other examples ● Demonstrate and explain examples of the four classic signs that tell whether a chemical reaction has occurred ● Demonstrate color change by showing students a dry steel wool pad (S.O.S., Brillo) and one that was soaked in water and allowed to sit for a day or two. Describe the differences and discuss the kind of change that occurred	food ● Get the before and after temperature of various reactions, graph the data, and analyze the data (ex. Baking soda and vinegar, liver and hydrogen peroxide, potato and hydrogen peroxide, cold packs, hot packs) ● Create and design a device that uses a chemical reaction to produce heat in or to cool a box as a way to keep your lunch either hot or cold. How can you alter the type or concentrations of substances to change the amount of heat produced or removed?	

4. MOTION AND FORCES

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Universal Law of Gravitation	● Invite Sir Isaac Newton to the classroom to explain gravitational force and his Universal Law of Gravitation. (Students can dress in costume) ● Differentiate between mass and weight ● Calculate the force of gravity on an object (weight) by using F=ma ● Show graphs of increasing mass verses gravitational force ● Show graphs of increasing distance verses gravitational force	● Research the work of Sir Isaac Newton and his Universal Law of Gravitation. Give an oral report on how his work helped people to understand force and motion ● Calculate weight of an object on the moon verses weight on Earth when given the mass and acceleration due to gravity on both Earth and the Moon	**MS-PS2-4** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

● Speed – velocity, acceleration, deceleration, terminal velocity, momentum	● Explain why tides are stronger when the sun and moon are in line. Use diagrams or draw a picture showing how the gravitational forces of the sun and moon act together to pull on the surface waters of the earth in the same direction ● Explain how the ability to determine the correct velocity is important to airplane pilots and ship captains who must arrive at their destinations on a schedule and conserve fuel. (Be sure to stress to students that the direction of velocity can be up or down, east or west, north or south)	● Explain that changes in velocity are either acceleration or deceleration. Imagine that you rolled a ping-pong ball down a bowling alley at a speed of 6 meters per second. Discuss what the ping-pong ball does as it hits the pins. Compare this to a bowling ball moving at 6 meters per second and what it does as it hits the pins. Explain why the impact of the ping-pong ball differs from that of the bowling ball. ● Research some favorite amusement park thrill rides and discuss how gravity affects the ride ● Research different occupations where knowledge of speed and velocity is important ● Explain why a hockey puck will travel faster and farther on smooth ice as compared to traveling on a road surface	
● Equilibrium, friction	● Identify several examples of how friction plays a part in everyday life	● Roll toy cars over various surfaces, e.g. *wax paper, tabletop, sandpaper, and cement floo*r, a distance of one meter. Complete a lab report and graph the results.	
● Newton's Laws of Motion (I, II, III)	● Show examples of Newton's Laws of Motion ● Students carry out a lab of examples ● Use Newton's Laws to explain the sensation of your stomach feeling like it "drops" suddenly on a	● Explain how seatbelts help prevent injuries in car accidents ● Explain why wearing a helmet is important ● Create a solution to limit the amount of damage when two cars crash into each other	**MS-PS2-1** Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

	rollercoaster ● Calculate the force on an object when given the mass and acceleration of the object (F=ma) ● Calculate the net force of an object when given two or more forces acting on it	● Use spring scales to determine the net force acting on stationary and moving objects ● Predict the motion that objects would have based on difference forces acting on it, and explain whether the forces are balanced or unbalanced	**MS-PS2-2** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
● Electricity, magnetism	● Provide materials for students to investigate magnetism Record their observations ● Discuss the importance of electrical safety in everyday life ● Demonstrate how electricity can be used to produce heat, light, and sound ● Brainstorm the impact that the use of electricity has had on the lives of people during the past century	● Explain why metals are good conductors of both heat and electricity ● Describe ways magnetism and electricity are similar ● Make models or pictures to show the magnetic properties of the Earth ● Label the magnetic poles, geographic poles, and the Earth's magnetic field ● Explain what causes electric current to flow ● Explain how life would be different if power plants and oil wells suddenly stopped working ● Conduct a lab using electromagnets, electric motors, or generators ● Demonstrate how you can increase the strength of an electromagnet by increasing the current or number of coils ● Create a device using magnets to move an object without it directly touching the object	**MS-PS2-3** Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. **MS-PS2-5** Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

● Simple machines and mechanical advantage	● Brainstorm with the students about how simple machines make life easier ● Research at least five of the most important machines from 1950 to the present then report findings to the class ● Discuss and demonstrate the six simple machines using a variety of toys ● Provide students with a smooth board, books, spring scale, to determine how a ramp can help them do work ● Identify the relationships between the forces involved in mechanical advantage and figure out the formula for determining mechanical advantage. Calculate the actual mechanical advantage of the ramp ● Explain compound machines. Discuss why a bike, scissors, tape dispenser, and pencil sharpener are compound machines. Collect pictures of compound machines used in everyday life ● Explore the cartoon work of Rube Goldberg who designed complicated devices to perform simple tasks ● Calculate the mechanical advantage of a machine	● Invent a new machine, while working in cooperative groups, which uses at least three simple machines. Make a diagram and name the new machine. Write an essay about what the machine does ● Cut out magazine pictures of machines that are based on simple machines. Circle the simple machine in each picture ● Explain how simple machines were used in building the pyramids 4,000 years ago	

● Bernoulli's Principle	● Identify the four forces acting on a moving plane	● Provide students with materials (e.g. ping pong balls, string, index cards) to investigate Bernoulli's Principle	

5. ENERGY AND ITS INTERACTION WITH MATTER

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Law of Conservation of Energy	● Explain the Law of Conservation of Energy ● Discuss potential energy and kinetic energy present when a person uses a bow and arrow ● Roll a ball down a ramp and explain how the potential and kinetic energy changes as the ball moves	● Explain potential energy and kinetic energy using a roller skater descending a hill ● Explain the type of energy that takes place as an object falls off a table ● Changing the distances of how high a ball is dropped, record how high the ball bounces and at what places it has the most potential and kinetic energy ● Using three balls of different masses, describe which rolls the fastest ● Create a method to create the most amount of static electricity on a balloon	**MS-PS3-1** Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. **MS-PS3-2**. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. **MS-PS3-5** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

● Forms of energy (solar, nuclear, mechanical, electrical, chemical, radiant) and heat transfer	● Explain examples of different types of energy ● Show examples of energy conversions (e.g. Electrical to light energy) ● Create a wind turbine using a DC motor, fan connection, PVC pipes and wires connected to a multimeter ● Explain how heat travels across space or through materials from warmer objects to cooler ones until both are at the same temperature ● Demonstrate how most substances expand when heated and contract when cooled, using the metal ball and ring apparatus ● Discuss what happens to water when it freezes ● Develop a display showing the three ways in which heat can be transferred, e.g. conduction, convection, and radiation ● Perform an experiment to determine how color affects heat absorption ● Make electromagnetic spectrums to view the visible light spectrum using diffraction grating ● Explain the two kinds of nuclear energy and how energy is released. Discuss the growing demand for energy and how nuclear reactions are one way to meet the demand	● Given different examples of energy, explain the types of energy and energy conversions ● Explain what makes solar energy a desirable energy source ● Explain why placing a metal knife in a glass before pouring hot water into it may prevent the glass from breaking ● Research and write a report about the need for expansion joints on a bridge ● Make a solar collector to heat water. Collect data, explain results, and explain conclusions ● Design a solar cooker to make s'mores ● Using different sizes of ice but the same amount and initial temperature of water, measure the initial and final water temperatures. Graph and explain ● Create an experiment that uses three different cups or insulation materials to surround the cups to see which insulation is most effective in keeping an ice cube frozen ● Design a small lunch box to keep an ice cube frozen for as long as possible	**MS-PS3-3** Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. **MS-PS3-4** Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

	● Explain, giving examples, how most mechanical energy is created by burning fuel (wood, coal, oil, natural gas) ● Discuss the dependence of electric power plants on fuels		
● Characteristics of waves	● Discuss what happens when pebbles are dropped into water ● Investigate the differences between transverse and longitudinal waves using ropes and Slinkys ● Explain how speed, frequency, and wavelength are related ● Demonstrate how sound can be produced by vibrating objects and how the pitch of the sound depends on the rate of vibration ● Explain the speed of sound and the factors that affect the speed of sound ● Explain what happens when you strike a tuning fork and touch the vibrating fork to the surface of water ● Explain how sound waves and electromagnetic waves differ ● Discuss how optical fibers use light waves to carry signals and messages ● Distinguish between reflected and refracted light. Explain why a pencil looks broken when placed in a glass of water ● Investigate sources of light and	● Research how waves are used in medicine, industry, and communication ● Use an online simulation to examine how increasing the amplitude of a wave increases its sound ● Describe how bats use sound waves of very high frequency to find their way and locate prey ● Explain how a moving ambulance siren exhibits the Doppler Effect ● Create a series of diagrams that illustrate how sound waves travel through matter ● Explain how light is reflected, refracted, or absorbed when it interacts with matter and how color appears as a result of this interaction ● Explain three kinds of electromagnetic waves and how each affects people ● Research and give an oral report on the development of x-rays ● Demonstrate how a Slinky can be used to show how waves transmit energy	**MS-PS4-1** Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. **MS-PS4-2** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

	show how light behaves when it strikes different surfaces ● Measure and determine the angle of reflection of a beam of light using light boxes ● Brainstorm what the source of solar energy is and the various ways energy is emitted (visible light, infrared, ultraviolet radiation)		
• Digital and analog signals	● Explain how waves are transmitted from one cell phone to another to carry information ● Demonstrate how microwave ovens use microwaves to heat food ● Explain how fiber optics transmit information	● Take pictures using a digital vs analog camera and compare the advantages and disadvantages of each camera ● Analog clock verses digital clock	**MS-PS4-3** Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.

Life Science Grades 6-8 Overview

This course of study can either be a year-long course or divided among grades 6, 7, and 8

Life Science	
1. The Cell ● structure and function of cell organelles: mitochondria, chromosomes, ribosome, lysosome, golgi bodies, vacuoles, cytoplasm, cell wall, cell membrane, chloroplast, endoplasmic reticulum ● cell growth and mitosis ● cellular Respiration and movement into/out of the cell ● Photosynthesis **2. Reproduction and Heredity/Genetics:** ● DNA structure ● Reproduction life cycles and patterns ● Environmental and genetic factors influence the growth of organisms **3. Evolution:** ● geologic time and fossil evidence of change ● Natural selection and Evolution ● Genetic engineering ● Graphing population changes	4. **Interdependence and Behavior of Organisms:** ● Behavior and structure affects function ● extinction of species ● Symbiosis (commensalism, mutualism, parasitism) ● food chains/food webs ● ecosystems/relationships within biomes ● human impact on the environment **5. Matter, Energy and Organization in Living Systems:** ● levels of organization and body systems ● classification of kingdoms

1. The Cell

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Structure and function of cell organelles: *Mitochondria, chromosomes, ribosomes, lysosomes, golgi bodies, vacuoles, cytoplasm, cell wall, cell membrane, chloroplast, endoplasmic reticulum*	● Make either a plant or animal cell out of various food items, with structures and functions labeled (gelatin, candy, pasta, yarn) ● Use an interactive website to learn about organelles (e.g. CellsAlive)	● Discuss and describe how the parts of a city or theme park interact and how the whole system could gradually break down if only one part stopped working ● Make a Venn diagram to compare and contrast animal and plant cells	**MS-LS1-2** Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.
● Cell theory ● Cell growth and mitosis	● Create a timeline that depicts the development of the cell theory ● Provide students with onions, toothpicks and beakers of water so that they can grow their own onion root tips ● Provide the proper staining materials and demonstrate how to prepare a stained onion root tip squash showing all the stages of mitosis. (Mitosis Kit) Examine the prepared slides under the microscope ● Examine pond water under a microscope to differentiate between unicellular and multicellular organisms	● Prepare slides of plant (onion, anacharis) and animal (human cheek) cells and examine them microscopically and compare their similarities and differences ● Act out the stages of mitosis. Discuss their roles with each other and how they will interact with other parts of the cell during mitosis ● Use different colors of clay to depict a stage of mitosis and attach an index card explaining what is happening	**MS-LS1-1** Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

● Cellular Respiration and movement into/out of the cell	● Yeast Respiration Lab ● Use an egg to demonstrate Osmosis and diffusion – hypertonicity, hypotonicity, isotonicity ● Egg Diffusion Lab: Students conduct an experiment to see how vinegar, water, and corn syrup affect the mass and appearance of an egg ● Prepare materials for groups of students to explore cell membranes and the movement of materials through cell membranes using dialysis tubing/plastic sandwich bag and a small molecule in solution (iodine) and a large molecule in solution (starch) ● Discuss the process of dehydrating foods	● Write an essay comparing photosynthesis to cellular respiration ● Create a Venn Diagram ● Demonstrate the effect of a hypotonic and/or a hypertonic solution on cells using potatoes/celery/ carrots, salt, water and containers ● Using the term osmosis write a descriptive paragraph describing the appearance of raisins before and after an overnight water bath ● Brainstorm how the wonderful cooking smells travel from the kitchen to all parts of the house ● Explain why a high concentration of salt causes water to diffuse out of cells	**MS-LS1-7** Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
● Processes of photosynthesis	● Experiment with Elodea (Anacharis) and Bromothymol Blue to demonstrate that plants take in carbon dioxide	● Make a prediction on how deforestation would affect atmospheric CO_2 levels	**MS-LS1-6** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

2. REPRODUCTION AND HEREDITY/GENETICS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● DNA structure	● Make a DNA model using materials such as pipe cleaners, beads, candies ● Students will use the models to describe the structure of DNA and explain how replication takes place	● Turn your name into a protein Lab DNA Paper Protein Chains Activity ● Genetic Puppies Lab DNA recipe for physical traits ● Research information on what kinds of mutations might make humans better able to survive. Research how ultraviolet radiation can cause mutations ● Make a picture collage display showing patterns of change in humans and other living things and how the life cycle continues	**MS-LS3-1** Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
● Reproduction life cycles and patterns	● Provide case studies for the students to discover how people inherit traits from their grandparents and to determine whether certain traits are dominant or recessive ● Generations of Traits Lab - conduct a lab to determine what potential offspring may look like based on the parents' or grandparents' genes ● Discuss with the students what they have discovered about the number of combinations possible when reproductive cells are formed by meiosis. ● Research sex-linked traits	● Research the work of Gregor Mendel and the principles of heredity. Students will share their resources with the class while giving oral reports ● Create a Punnett Square to predict what offspring will look like ● Plastic Egg Genetics	**MS-LS3-2** Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

● Environmental and genetic factors influence the growth of organisms	● Inform students about the Killer Bee and other genetic crosses ● Conduct an experiment with seeds in a bag with water vs other liquids to see how growth is affected by each liquid ● Students will associate chromosomes with their important role in shaping evolution	● Using the computer, make a bar graph of the number of students with dominant and recessive traits in their classroom; right or left-handed, tongue roller or not, brown eyes or blue eyes, dark hair or fair hair, widow's peak or not, hitchhiker's thumb or not. Use any biology textbook for characteristic dominant and recessive traits ● Draw a Punnett Square to illustrate how two brown-eyed parents could have blue-eyed offspring ● Cooperatively brainstorm the best and worst outcomes in trying to achieve desired combinations of traits in animals and share their ideas with the class	**MS-LS1-5** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

3. EVOLUTION

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Geologic time and fossil evidence of change	● Develop a geologic timeline to display ● Will research and investigate geologic time periods ● Show Discovery Channel's Planet of Life videos ● Provide sample fossil evidence and examine fossil records ● Discuss what must happen to an organism for it to become a fossil.	● Research the age of fossils including environmental conditions and the organisms that lived through each period ● Working in groups, students will examine different sets of identified fossils that are representative of life during a particular period of geologic time ● Sketch fossils and determine the	**MS-LS4-1** Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate

	Explain why boney body parts like shells, bones and teeth become fossilized more often than soft body parts ● Create an index fossil record	time and environment in which the organism lived ● Create presentations that picture life during a particular period or era of geologic time	today as in the past.
• Homologous structures	● Examine x-ray photos of a Human, Dog, Bird, and Whale to show similar ancestry ● Legends of Learning: Embryological evidence for common ancestry digital game	● Explain how modern sharks compare to sharks that lived millions of years ago ● Research the link between dinosaurs and modern birds ● If given four species, using anatomical evidence, explain which species are most closely related	**MS-LS4-2** Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.
● Embryological development	● Examine images of embryological development of various vertebrates and observe similarities in each ● Which one is human? Given a picture of 6 embryos, have students guess which is the human embryo	● If given four species, using embryological evidence, explain which species are most closely related	**MS-LS4-3** Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.
● Natural selection and evolution	● Use Discovery Channel programs and other resources to explore evolution ● Understand natural selection over	● Invent a new creature that has adapted to a new environment over time, showing unique characteristics of the species and	**MS-LS4-4** Construct an explanation based on evidence that describes how genetic variations of

	time by explaining Darwin's finches and the peppered moths in Manchester, England ● Select an organism and prepare a display to show how it has changed through time. How have plants (tomatoes, corn) or animals (cattle, pigs) changed in the last two hundred years? ● Using metric rulers, students measure the length of their thumb to the nearest millimeter to show the variations among classmates. Have the students share, graph and interpret the results	show changes in general over time ● Research and present information on streptomycin resistance in bacteria ● Research Darwin's Theory of Evolution by Natural Selection and present an oral report ● Research animals of the Galapagos Islands in cooperative groups. Present illustrated reports to the class	traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.
● Genetic Engineering	● Research Genetically Modified Organisms (GMO's)	● Show human evolution of distinguishing facial characteristics using clay sculpture to depict changes over time	**MS-LS4-5** Gather and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms.
● Graphing population changes	● How Many Bears Can Live In This Forest Game-Students will be able to define a major component of habitat and identify limiting factors while pretending to be bears foraging for food	● Peppered Moth Population in England: Using data, create a graph and use it to explain why the populations of peppered moths changed during a period of higher pollution	**MS-LS4-6** Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

4. INTERDEPENDENCE OF ORGANISMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Behavior and structure affects function	● Construction of robotic arm using piping, wooden craft sticks, small hand pumps, tape, or articulating Lego pieces ● Choose one animal from the desert, rainforest or ocean and explain its environment and adaptations to its surroundings ● Make a chart with different categories of behavior and reasons for them ● Explain the differences between innate and learned behavior ● Invite a veterinarian or obedience trainer to class to discuss basic animal behavior characteristics ● Show documentary on the life and work of famous naturalist, such as, Jane Goodall, Diane Fossey, and Marley Mowat ● Show video on bird migration. Invite a guest speaker from Audubon Society or Fish and Wildlife Agency to discuss bird migration ● In the spring, construct a Monarch butterfly nest and keep a log on development of the larva ● Explain how ants produce an alarm chemical anytime danger is	● Count and list how many characteristics separate humans from other species. ● Write a report on documentaries of one of the naturalists ● Bring in pictures of various types of behavior in animal or plant life. Give oral presentation ● Using the Internet, investigate migrations of certain species of waterfowl ● Write a report on movie, “Fly Away” or “Winged Migration” ● List at least two activities today that show you have innate behavior ● Keep a study of your own body rhythms, activities and feelings. Determine if they are in a regular pattern	**MS-LS1-4** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. **MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS4-4** Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals’ probability of

	encountered ● Research the hibernation of bears ● Investigate how a mammals' ear changes sound waves to nerve impulses ● Investigate movement of paramecium on slide ● Label a drawing of a mammal's ear and explain function of major parts		surviving and reproducing in a specific environment.
● Extinction of species	● Research animals that have gone extinct in the last hundred years ● Research the Endangered Species Act	● Research on how wolves may affect many aspects of the ecosystem. Cite examples in our nation's history with wolves in Yellowstone from 1900-present	**MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
● Symbiosis, commensalism, mutualism, parasitism	● Compare and contrast organisms regarding the three major kinds of symbiotic relationships ● Describe the relationship between clownfish and sea anemone ● Create a model showing some form of relationship. Create your own organism. Label your model. ● Human beings and bacteria E. coli have a mutually beneficial relationship. Explain the importance of this relationship. List the foods that encourage good intestinal functioning ● The buffalo and cattle egret have a beneficial relationship; explain the importance of this relationship.	● Students make a chart of the three types of symbiotic relationships and identify examples organisms that are involved in each type ● Draw and color diagram illustrating how flower and butterfly benefit each other ● Research and write a report on how orchids benefit from living in trees ● Using computers, type a report on the whales and their relationship with barnacles ● Explain how the plover bird gets its food and the crocodile gets its mouth cleaned	**MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

	How does it benefit all of nature? In the sea, barnacles survive while being attached to whales. Use digital media that features various forms of sea life especially the habitat		
● Food chain, food web	● Dissect an owl pellet; explain what owl pellets contain, where they are obtained and how they will be studied ● Given a particular ecosystem, describe what organisms are the producer, consumer, and decomposer ● Play the food web game. Show how an apple tree can be food and shelter for different organisms ● Choose an ecosystem and make a collage that shows the biotic and abiotic things that interact in it. Provide students with wildlife and nature magazines and large sheets of poster board	● Using an owl pellet, reconstruct a skeleton of a vole ● Survey the school grounds to determine the consumers, decomposers and producers. Explain how carbon is cycling among all of those organisms, and how they either directly or indirectly use energy from the sun ● What are the predator/prey relationships? Construct a food web of the organisms found in the schoolyard ● Draw an ocean web cycle	**MS-LS2-3** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
● Ecosystems/relations hips within biomes	● Research different types of soil and report their findings to the class ● Introduce the various scientifically accurate fiction books of different biomes by author, Jean Craighead George	● Distinguish the major biomes on the basis of solar energy, rainfall, temperature and soil, and record results ● Research how populations have changed due to a change in the environment	**MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
● Human impact on the environment	● Show a video on the 1989 Exxon Valdez oil spill or 2010 BP Oil Spill. Elicit students' reactions to the presentation of how the cleanup	● Prepare a research paper, which examines the following issue: Some cattle ranchers and farmers want to get rid of wolves and coyotes	**MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and

	was approached ● Read excerpts from Rachel Carson's book, *Silent Spring*, Publisher: Signet Science Library ● Try the Oil Spill STEM Challenge, use the materials provided, students will develop a plan to remove the most oil from a simulated oil spill disaster which includes feathers to represent marine life - stemactivitesforkids.com	because they are predators that kill their livestock. What would happen if these animals were no longer in the community? What problems might occur? Would it seriously affect the community? ● Construct an explanation of a fossil record. Hypothesize about the effects of environmental change and catastrophic events on organisms and populations ● Create a design solution for an oil spill with a tub of water filled with rocks and sand contaminated with motor oil. Determine the best (least detrimental to the environment) way to clean up the oil using cotton balls, paper towels, cotton swabs, baking soda, brushes and detergent. Write and share lab reports.	ecosystem services.

5. MATTER, ENERGY AND ORGANIZATION IN LIVING SYSTEMS

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Levels of organization and body systems	● Using pictures, differentiate among a cell, tissue, organ, and organ system ● Cup stacking hierarchy, atom to organism ● Cell Model use various media, candy, cardboard, foam	● Label all of the major bones and joints on a paper skeleton ● Diagram and explain what happens to their lunch from the first bite up to when it is ready to leave the body. ● Classify the muscles of the human	**MS-LS1-3** Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

	● Examine beef bones and chicken bones from the supermarket ● View The National Geographic video, "The Incredible Human Machine." Discuss function and parts of the skeletal system and the various joints using a full-size plastic model skeleton ● Observe the action of their arm muscles. Observe the skeletal muscle tissue of a chicken leg and chicken wing. Make prepared slides of this muscle tissue for observation under the microscope ● Discuss the three types of muscle in the human body: skeletal, smooth and cardiac. Discuss how muscles work in pairs ● Outline the body of one group member and then label the major muscles of each main body area ● Investigate the parts and function of the digestive system using digital media ● Learn how the heart works and the function of the blood vessels by using a flow chart ● Keep a food log of your weekly diet. Students will compare their diet to the suggested choices on The Food Pyramid Guide ● Examine the circulation of blood (arteries, veins and capillaries) in the tail of a goldfish using the	body ● Describe a journey through a person's digestive system ending with the process of absorption ● Diagram and label the heart and the major arteries and veins of the human body. Color and make a flow chart of systemic and pulmonary circulation ● Write an advertisement to dissuade tobacco use. ● Explain the path of a nerve impulse when the phone rings ● Prepare a flow chart of the structures of the excretory system. Discuss the collection of waste products and their removal from the body ● Write a paragraph explaining how their skin provides a tough, flexible, protective covering while helping to maintain a constant body temperature ● Draw diagrams showing the relationship between photosynthesis and respiration ● Research and prepare oral reports on the benefits of an aerobic exercise program ● Compare the function of the skin when a person is taking a walk on a freezing day with a walk on a 100-degree day. Brainstorm all of the ways that skin is important and	**MS-LS1-8** Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

	microscope ● Investigate the structure and function of the lungs by inhaling and exhaling with a tape measure around their chest ● Discuss the structure and function of the endocrine glands. Make clay models and label and explain the function of each structure. Discuss how negative feedback controls hormone levels ● Play the game of "Freeze" to show how the endocrine system regulates activities ● Explain how urine is produced in the kidneys. Discuss dialysis and its importance	prepare a list for the whole class ● Using audiovisual aids that they have made, students will make a presentation about the hazardous effects of smoking to their peers. ● Create a flow chart to track blood as it goes through blood vessels in the heart ● Discuss the three types of neurons and how they interact. Using reflex action, explore the CNS – Central Nervous System and the PNS – Peripheral Nervous System ● Make a brain manipulative model to show how the nervous system regulates activities ● Measure the overall surface area (length and width) of the major body parts: head, neck, trunk, arms and leg to see that skin is the largest body organ	
● Classification of life (Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species)	● Students create a mnemonic to remember the order of classification	● Students research different animals to create a classification	

Grade 6-7-8 Science Curriculum

Earth and Space Science

Earth Science		
1. Composition of the Earth and the Dynamics that Shape it	**2. Origin and Evolution of the Universe**	**3. Space Exploration**
● Structure of the earth system: geosphere, plate tectonics and its effect on the geosphere, hydrosphere, history of the Earth, glacial deposits, fossils ● Weather systems and climate ● Geochemical and geophysical cycles ● Effects of catastrophic events ● Human impacts on the Earth ● Global climate change	● The Universe Formation stars, “Big Bang Theory” ● Components of the solar system ● Observations of movement of objects ● Sun-Earth-Moon interactions ● Seasons ● Effect of gravity on celestial bodies	● Early space exploration and history of the space program, past explorations discoveries, internet explorations/downloading of resources, virtual reality on space

1. COMPOSITION OF THE EARTH AND THE DYNAMICS THAT SHAPE IT

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Geosphere	● Describe the size of the crust, mantle and core of the earth and describe the characteristics (rock makeup and density) of each layer ● Show a series of pictures that contain the three distinct rock types. Explain to students how they can see the difference in the three major rock types based on major physical properties ● Invite a soil scientist to class to discuss soils, soil types and soil profiles ● Describe the processes that form igneous, sedimentary and metamorphic rock ● Describe the three types while showing examples ● Collect a variety of soil samples to examine for texture, color and soil type ● Using a soil test kit, test a variety of soils for nitrogen (N), Phosphorus (P) and Potash (K) content, and pH	● Make an analogy between a hard-boiled egg and the layers of the earth. The groups should make drawings of the layers. Drawings should show the crust, mantle and core and depths for each ● Using four colors of clay, make a model of the earth's layers. Make a model to scale. Allow 1 cm=1000 Km ● Take a field trip stopping at several sites to collect a variety of rocks. Key out the various rocks and label them for a classroom collection ● Model different types of rocks ● Collect a box of rocks that includes all three-rock types. Choose from the box and classify it as igneous, sedimentary or metamorphic rock ● List the processes that form the three types of rocks and why the name given to each type is appropriate	**MS-ESS3-1** Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

● Plate tectonics and its effect on the geosphere	● Research fossils and rock types that have existed in different countries that may have once been joined	● Re-create a map of the Earth as it would have theoretically existed as Pangaea, by using puzzle pieces that have fossils or rock types drawn on them (AMNH Plate Tectonics Puzzle) ● Describe a series of stages the earth has undergone in becoming what it is today. Using props, show how a glacier acts like a huge river of ice, tearing up rock and moving it	**MS-ESS2-3** Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.
● Hydrosphere	● Use the water cycle to explain how different types of weather occur ● Research current environmental issues ● Identify the benefits of being stewards of the environment, ● Elaborate on environmental problems, e.g., air pollution, acid rain, ocean acidification. Discuss the importance of the proper disposal of toxic wastes, and calculate their personal carbon footprint	● Identify the ecosystems and watersheds present in your county ● Discuss sunlight, pollution, acid rain, erosion, resources, water sources, recycling and waste disposal ● Research the Dust Bowl of the 1930's ● Conduct an experiment where one cup of water is sitting in sunlight and another cup is in the closet	**MS-ESS2-4** Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

● History of the Earth, glacial deposits, fossils	● Explain the difference between Relative and Radiometric Dating ● Take the students to see a road cut. See if they can figure out the earth's history by studying the road cut ● Research websites for three types of volcanoes ● Visit a natural history museum to observe evidence of early glaciation in bedrock ● Explain how scientists use radioactive dating to determine the age of fossils ● Invite a geologist to talk to the class about how they determine if rock layers are related in age	● Compare different rock strata to determine which is the oldest ● Based on research data, calculate the age of a rock based on the percent of radioactive materials (Uranium vs Lead, Rubidium vs Strontium, etc.) ● In a research paper, explain how it is believed to have been a massive combination of today's separate continents in a research paper ● Discuss experiences with fossils. Explain how fossils can determine what living organisms were like millions of years ago. Make a collection of different types of fossils and identify their time period	**MS-ESS1-4** Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6 billion-year-old history.
● Weather systems and climate	● Identify the characteristics of the various climate regions in the world ● Construct a weather station in school and record the weather changes ● In groups, devise ways to predict the weather and record accuracy over a period of time ● Describe different types of winds, such as global winds and local winds ● Explain how ocean circulation can affect the transfer of heat	● Describe the climate region in the world where you would like to live and explain why ● Describe the conditions that would be present if the weather changes from clear to stormy, or from stormy to clear ● Analyze data on how latitude, altitude, and land distribution affect temperatures	**MS-ESS2-5** Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions. **ESS2-6** Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

● Geochemical and geophysical cycles, effects of catastrophic events	● Explain how landforms are the results of a combination of constructive forces (crystal deformation, volcanic eruption and deposition of sediment) and destructive forces (weathering and erosion) using a world map ● Brainstorm the cause of mechanical weathering ● Use diagrams that illustrate the process of soil formation and water percolation ● Explain what percentage of the soil on the earth is used for growing crops, how fragile it is and how it sustains life	● Research how Earth's history has been influenced by catastrophes such as the impact of an asteroid (meteoroid) or comet ● Choose one of the natural processes that shape the earth's crust and make a model using clay, plaster of paris, soil and other available materials. Explain if your natural process is a result of a constructive or destructive force and why ● Use the information about erosion and sedimentation from the classroom discussion to create a labeled diagram to show the process as it happens on a river ● Invite a student group to lead a discussion in which other students determine that wind and water cause changes in the shape of the earth. ● Research the nearest hill or mountain area and write a story describing how the surface of the earth may have changed over time. ● Present the rock cycle as an orderly model of a dynamic Earth	**MS-ESS2-1** Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. **MS-ESS2-2** Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. **MS-ESS3-2** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

● Human impacts on the Earth, global climate change	● Research impact of pesticides and fertilizers on soil and watershed ● Research impact of wastewater discharge into waterways ● Research the impact of an increase in demand for clean water on the supply of water or on the environment ● Research the impact of deforestation ● Present various credible modern climatologist climate change theories discuss their data ● Research how human population can limit resources such as food, energy, and medicines, as well as ecosystem services that humans rely on e.g. water purification and recycling	● Create a plan to improve an area near the school (e.g. start a recycling program, how to minimize electric use in the school, how to minimize water usage) ● Analyze data of human populations and atmospheric carbon dioxide concentrations over time ● Research the effects of ocean acidification due to a higher ocean concentration of carbon dioxide ● Hold a class debate where students research, make claims, and support their claims with evidence on what may have caused a rise in global temperatures	**MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. **MS-ESS3-4** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. **MS-ESS3-5** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

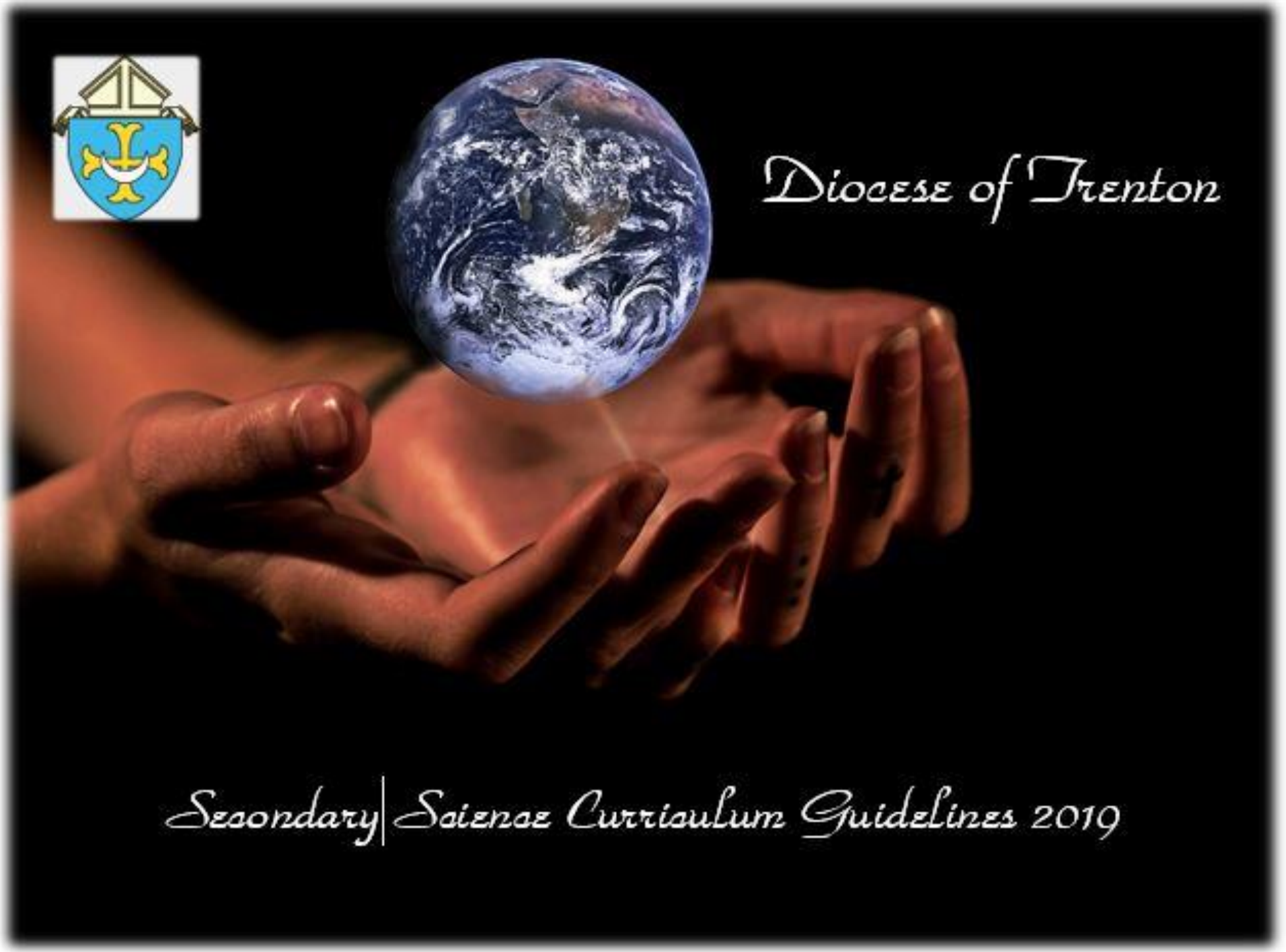
2. Origin and Evolution of the Universe

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● The Universe Formation, stars, “Big Bang Theory”	● Put spots on a balloon then inflate, observe and discuss what happens to the spots ● Describe how the Doppler shift is caused and show how the Doppler shift supports the “Big Bang Theory”	● Write a research report on the origins of the universe	
● Components of the solar system	● Use the classroom to create a life-size scale of the solar system to demonstrate distances between planets and the Sun	● Write a paper describing what would happen on earth if the sun gradually faded and disappeared	**MS-ESS1-3** Analyze and interpret data to determine scale properties of objects in the solar system.

● Observations of movement of objects sun-earth-moon interactions, seasons	● Demonstrate the proper way of viewing the sun using two index cards. Put a large pinhole in one card. Take the class outside. **CAUTION** students to **NEVER** look directly at the sun. Relate this demonstration to a solar eclipse ● Show students partial, total or ring-like solar eclipses. Inform students when a solar eclipse is due to occur (usually two times a year) ● Demonstrate day and night by modeling the earth as it spins on its axis by using a light source for the sun	● Explain where the sun's enormous energy comes from with the aid of internet ● Draw a diagram to show how different parts of the earth get direct sunlight at different times of the year to explain what causes the seasons ● Observe and record the change of the sun's position over the school year. Keep a journal and explain how the changes affect you ● Research Johannes Kepler's Laws of Planetary Motion and present the information to the class ● Demonstrate eclipses of the sun and moon ● Discover the sequence of the phases of the moon by observing and recording them over a month's time. Research some of the superstitions about the phases of the moon.	**MS-ESS1-1** Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
● Effect of gravity on celestial bodies	● Compare the size and mass of celestial bodies that orbit other celestial bodies	● Prepare a presentation for a lower grade. Explain why the nine planets orbit around the sun. Include an explanation of the gravitational attraction	**MS-ESS1-2** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

3. SPACE EXPLORATION

CORE CONTENT	INSTRUCTIONAL STRATEGIES	ASSESSMENT STRATEGIES	NGSS OUTCOME
● Early space exploration & history of the space program	● Research the contributions of Galileo, Sir Isaac Newton, Johann Kepler ● Research historical missions and global space programs carried out by the U.S. and the Soviet (Russia).Compare the programs in terms of their goals and accomplishments ● Research the history of the space program ● Introduce the early study of space and compare the early telescopes ● Research rockets, capsules and space shuttles ● Explain Hubble's Law and its significance ● Discuss the Law of Gravitation ● Download the free digital copy of Beyond Earth: A Chronicle of Deep Space Exploration at NASA have students pick a topic and present the information from it, or play a digital game at ISSKidsZone.gov	● Choose one particular space mission to research and be prepared to share your information with the class ● Make up a JEOPARDY style game to be played by the class using all of the information you have learned regarding exploring space and the space program. ● Virtual reality tours of space	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Section V

Introduction to the Newly Revised Diocesan Secondary Science Curriculum

"Science is like a game. In the presentation of a scientific problem, the other player is the Lord. He has not only set the problem but also has devised the rules of the game – but they are not completely known, half of them are left for you to discover or to deduce." —Erwin Schroedinger

As science educators in the Diocese of Trenton, we are called to honor, enhance, cultivate and encourage the innate natural curiosity of all the students entrusted to our care. We work to help students develop and foster a deeper appreciation of the great diversity of life and their role as stewards of God's creations. We are further challenged to provide these students with an educational experience that provides them with the skills necessary to understand and evaluate current and future scientific and technological issues and advances. This is the foundation and justification of a STEM based education centered around the integration of science and engineering practices.

Incorporated in this curriculum guide are the fundamental concepts and topics of Biology, Chemistry, and Physics along with the Science and Engineering practices identified by the Next Generation Science Standards (NGSS). Teachers are provided the freedom to incorporate each of these 9 practices throughout the delivery of the curriculum as it applies to the needs of their students and courses. Specific examples of integration into the curriculum are provided as a guideline only.

This secondary curriculum has been developed in conjunction with the Diocese of Trenton's Pre-K through 8th Grade educators. It has been designed knowing students will begin their secondary education with the following skills: observation, reasoning, following directions, the metric system, applying the scientific method, the Nature of Sciences, and finally, the realization that science is not just a lab. It is for this reason that every level of science educator be familiar with the elementary, middle school and secondary curricula.

Integration of Science and Engineering Practices

Develop and use models:

Scientists and Engineers use models (from here on, for the sake of simplicity, we use the term "models" to refer to conceptual models rather than mental models) to represent their current understanding of a system (or parts of a system) under study, to aid in the development of questions and explanations, and to communicate ideas to others.

Integration into the curriculum:

Biology:
The evolution of the cell membrane models including:
- Gorter & Grendel (1925)
- Davson & Danielli (1940-1960)
- Singer & Nicolsons (1972)

Exchange of genetic material via crossing over

Chemistry:
The atomic theory and the evolution of the various atomic models
Molecular models and bonding models (sigma and pi)

Physics:
The use of mathematical models to demonstrate natural laws including, for example:
- Newton's laws of motion
- Newton's law of universal gravitation

Planning and carrying out investigations:

Scientists and engineers investigate and observe the world with essentially two goals: (1) to systematically describe the world and (2) to develop and test theories and explanations of how the world works.

Integration into the curriculum:

Biology:
Students should be encouraged to develop a procedure that allows them to solve a biology-based problem or determine an unknown. Examples include:
- Design a procedure to determine the molarity of several solutions to demonstrate knowledge of osmosis, diffusion and tonicity.
- Design a procedure to determine the optimal temperature/pH/substrate concentration for a given enzyme.

Chemistry:
Students should be encouraged to generate a procedure that allows them to either solve chemistry-based problem or determine an unknown. Examples include:
- Separation of materials (salt, sand, iron filings and aluminum shot)
- Flame tests

Physics:
Students should be encouraged to develop a procedure that allows them to investigate and demonstrate Newton's laws and various other kinematics concepts.

Obtaining, Evaluating, and Communicating Information
Being literate in science and engineering requires the ability to read and understand their literatures. Science and engineering are ways of knowing that are represented and communicated by words, diagrams, charts, graphs, images, symbols, and mathematics. Reading, interpreting, and producing text, are fundamental practices of science in particular, and they constitute at least half of engineers' and scientists' total working time

Integration into the curriculum

Biology/Chemistry/Physics:
Students should be provided the opportunity to identify with scientists and the way that scientists gain and share knowledge and approach their works. Communication of scientific knowledge by students should reflect that this knowledge is continually being extended, refined and revised by the community.

Using Mathematics and Computational Thinking

Mathematics and computational tools are central to science and engineering. Mathematics enables the numerical representation of variables, the symbolic representation of relationships between physical entities, and the prediction of outcomes. Mathematics provides powerful models for describing and predicting such phenomena as atomic structure, gravitational forces, and quantum mechanics.

Integration into the curriculum:

Biology:
Understanding and application of various statistical test for significance of data including:

- Standard Deviation
- Standard error of the mean
- Chi-square
- t-Test

Chemistry:
Dimensional Analysis and Stoichiometry

Physics:
Use of the GUESS Method, or other problem solving strategies as they relate to kinematics and other course topics.

Constructing Explanations and Designing Solutions

Because science seeks to enhance human understanding of the world, scientific theories are developed to provide explanations aimed at illuminating the nature of particular phenomena, predicting future events, or making inferences about past events.

- Scientific theories are constructs based on significant bodies of knowledge and evidence, are revised in light of new evidence, and must withstand significant scrutiny by the scientific community before they are widely accepted and applied.
- A scientific hypothesis is neither a scientific theory nor a guess; it is a plausible explanation for an observed phenomenon that can predict what will happen in a given situation.

Integration into the curriculum:

Biology, Chemistry and Physics:
Providing students the opportunity to design their own experiment or laboratory protocol focused on a natural phenomenon with an emphasis on problem solving.

Engaging in Argument from Evidence

In science, the production of knowledge is dependent on a process of reasoning that requires a scientist to make a justified claim about the world. In response, other scientists attempt to identify the claim's weaknesses and limitations. Their arguments can be based on deductions from premises, on inductive generalizations of existing patterns, or on inferences about the best possible explanation. Argumentation is also needed to resolve questions involving, for example, the best experimental design, the most appropriate techniques of data analysis, or the best interpretation of a given data set.

Integration into the curriculum:
Students should be encouraged to generate a claim based off of a question and required to provide evidence and reasoning to support this claim. Students should also be encouraged to generate counter-arguments to fellow students' claims and provide evidence and reasoning for the rebuttal. Topics include:

Biology:
Population dynamics
Selective permeability

Chemistry:
Conservation of mass: burning of alcohol.

Physics:
Weight distribution

Additional resources can be found at: Phenomena for NGSS

Analyzing and Interpreting Data

Once collected, data must be presented in a form that can reveal any patterns and relationships and that allows results to be communicated to others. Because raw data as such have little meaning, a major practice of scientists is to organize and interpret data through tabulating, graphing, or statistical analysis. Such analysis can bring out the meaning of data—and their relevance—so that they may be used as evidence.

Integration into the curriculum:
Biology, Chemistry and Physics:
Providing students with the opportunity to both graphically display data and analyze data significance with the appropriate statistical test, allowing students to have a deeper understanding of data meaning.

Incorporate the appropriate use of spreadsheets for data collection, and statistical analysis and computation

Statistical analysis and data analysis can include: standard deviation, standard error of the mean, hypothesis testing, best- fit line, slope intercept, etc.

Asking Questions and Defining Problems

Questions are the engine that drive science and engineering. Asking questions is essential to developing scientific habits of mind. Even for individuals who do not become scientists or engineers, the ability to ask well-defined questions is an important component of science literacy, helping to make them critical consumers of scientific knowledge.

Integration into the curriculum:

Biology, Chemistry and Physics:
Providing students the opportunity to design their own experiment or laboratory protocol centered around a student generated question regarding a natural phenomenon.

Obtaining, Evaluating and Communication Information

Scientists and engineers must be able to communicate clearly and persuasively present the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

Integration into the curriculum:

Biology, Chemistry and Physics:
Providing students the opportunity to read primary source articles regarding the curriculum content and sharing their summary and analysis in either written or verbal formats.

Providing students the opportunity to read, analyze and debate conflicting viewpoints in the discipline specific science curriculum.

References

National Research Council; Division of Behavioral and Social Sciences and Education; Board on Science Education; Committee on a Conceptual Framework for New K-12 Science Education Standards. (2011, July 19). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Retrieved from https://www.nap.edu/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts

BIOLOGY

Secondary Level

National Standards and Benchmarks for Effective Catholic Secondary Schools

Domain: Mission and Catholic Identity; Standard 1

- *An excellent Catholic school is guided and driven by a clearly communicated mission that embraces a Catholic Identity rooted in Gospel values, Centered on the Eucharist, and committed to faith formation, academic excellence and service.*

Domain: Academic Excellence; Standard 7; Benchmark 7.2 &7.3

- *An excellent Catholic school has a clearly articulated, rigorous curriculum aligned with relevant standards, 21st century skills, and Gospel values, implemented through effective instruction.*
  - *Standards are adopted across the curriculum, and include integration of the religious, spiritual, moral, and ethical dimensions of learning in all subjects.*
  - *Curriculum and instruction for 21st century learning provide students with the knowledge, understanding and skills to become creative, reflective, literate, critical, and moral evaluators, problem solvers, decision makers, and socially responsible global citizens.*

Diocesan Standards:

- *Students will be knowledgeable enough in the science of biology that they can engage in research and analysis effectively*
- *Students will develop a strong foundation allowing them to think critically and act as responsible citizens of the earth.*

Diocesan Outcomes:

- ***Through the study of the sciences, students will become thoughtful problem solvers***
- ***Students will utilize scientific skills to contribute to the solution of real world problems***
- ***Students will use the appropriate scientific models to describe and quantify the nature and interactions of matter and energy***
- ***Students will be able to discuss the scientific principles that are applicable to their everyday lives***
- ***Students will develop a respect for the study of the sciences***

Overarching Essential Questions:

- ***How does the structure and organization of cells relate to the chemical processes that occur within them***
- ***Describe the mechanism of inheritance and reproduction.***
- ***How does biological science promote understanding the evolving nature of life.***
- ***How does biology explore the interdependent relationships that exist in an ecosystem.***
- ***Explain the processes and chemical nature of energy and matter in living systems.***

***Note Regarding Dissection*:**

The Diocese of Trenton is dedicated to teaching and developing responsible attitudes and a general respect and reverence for all living organisms. We also recognize the historical and current importance of animals in the field of science, especially in the area of research. After careful consideration of various current views, the curriculum committee highly encourages the following guidelines be adapted in all Diocesan secondary science classes.

- Dissection should only be considered for upper level instruction and must only be used if there are no other acceptable alternatives for teaching the relationship of structure and function.
- No students should be forced to participate in any dissection; alternative methods must be made available.
- The use of vertebrates in student research must be limited to advanced science courses and should strive to utilize the least sentient vertebrate that applies to the research.

Topics:

1. **Biological Chemistry**
   - Chemistry of water, pH
   - Chemical nature of the cell: structure of macromolecules: Carbohydrates, Lipids, Nucleic Acids, Proteins
   - Enzymes

2. **The Cell**
   - Cellular transport processes
   - Cell division (mitosis)
   - Relationship between structure and function: cell parts and specialization

3. **Matter, Energy and Organization in Living Systems:**
   - Chemical nature of photosynthesis
   - Chemical nature of cellular respiration
   - Relationship between energy and matter in photosynthesis
   - Importance of the ATP molecule
   - Matter and energy as limiting factors in distribution and numbers of organisms
   - Laws of conservation as matter and energy travel through organisms

4. **Reproduction and Heredity:**
   - Meiosis (comparative study with mitosis)
   - Chemical nature of nucleic acids (DNA and RNA)
   - Relationship of structure to function of nucleic acids
   - Protein synthesis: transcription and translation
   - Mendelian genetics: terminology; analyze, predict and incorporate probability of various crosses.
     - Human inheritance: types, disorders and mutations
     - Genetic engineering: human genome; moral and ethical issues

5. **Evolution:**
   Evidence of evolution
   Darwinian Theory: how populations adapt (natural selection)
   Evolution as an on-going process: modern day examples
   How genetics applies to evolution
   Controversial issues surrounding evolution: origin of life; age of the earth

6. **Interdependence of Organisms:**
   Interactions within a community: food webs, predator/prey adaptations, symbiosis
   Population growth analysis
   Ecological issues which impact interdependence of organisms: acid rain; global warming; ozone depletion
   Energy flow in ecosystems

Key Areas and Content

Math in Biology

Some specific mathematics skills that students in this course will have the opportunity to apply, and should be familiar with prior to beginning their study of Biology are:

- *Construct and use tables and graphs to interpret data sets*
- *Solve algebraic expressions and literal equations*
- *Perform basic statistical procedures to analyze the center and spread of data*
- *Measure with accuracy and precision (e.g., length, volume, mass, temperature, time)*
- *Convert within a unit (e.g., centimeters to meters) using the factor label method*
- *Use common prefixes such as milli-, centi-, and kilo-*
- *Use scientific notation, where appropriate*
- *Use ratio and proportion to solve problems*

Biological Chemistry

Essential Questions:

- How does life result from chemical structure and function?
- Which properties of water contribute to Earth's fitness for life?

Core Content: Topics should include, but not be limited to:

- Chemical nature of the cell:
- Structure of macromolecules enzymes

Outcomes: By the end of twelfth grade students will be able to:

- Compare the functional groups characteristic of biologically important molecules.
- For carbohydrates, lipids, proteins and nucleic acids identify elements, building block molecules, examples and special functions.
- Describe the reactions that store energy in the construction of biochemical polymers and release energy by breaking these bonds.
- Discuss how biological catalysts, regulating biochemical processes in the cell, demonstrate these reactions.

Instructional Strategies:

- Using organic molecule kits, build models and demonstrate the process of biosynthesis in the formation of carbohydrates, lipids and proteins from their respective monomers.
- Use YouTube presentations or power point slides to show how the 3-D shape of protein determines function and how enzymes are specific to their jobs based on structure.

Assessment Strategies:

- Test the pH of a variety of solutions and observe the effect of buffers on pH.
- Use nutrient indicators to test for sugar, starch, protein and fats in food samples.
- Use potato, yeast or chicken liver as a source of catalase to observe its effect on hydrogen peroxide.

Teacher Notes:

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The Cell

Essential Questions:

- How does life result from cellular structure and function?
- How is structure related to function at all biological levels of organization?
- How do organisms maintain a biological balance between their internal and external environments?
- How do cells grow and reproduce?
- What are the advantages of multicellularity?

Core Content: Topics should include, but not be limited to:

- Cellular transport processes
- Cell division (mitosis)
- Relationship between structure and function: cell parts cell specialization

Outcomes: By the end of twelfth grade students will be able to:

- Compare the structure of prokaryotic cells.
- Relate structural adaptations of eukaryotic organelles to specific functions.
- Explain how membrane structure regulates movement of molecules into and out of cells.
- Describe the changes that occur in plant and animal cells during the phases of mitosis.

Assessment Strategies:

- Conduct a microscopic comparative study of various animal and plant cells. The students can also utilize google images. Include single-celled organisms and relate structure of parts to function.
- Using a variety of lab equipment, develop demonstrations showing diffusion, a cell's reaction to hypotonic, hypertonic and isotonic solutions and/or plant cells response to turgor pressure and plasmolysis.
- Develop a timeline showing the contributions of individual scientists to the cell theory and/or biogenesis. The time line could also include the history of the technology needed to advance the topic. This time could become an ongoing project as other topics are studied.

Instructional Strategies:

- Conduct a discussion on whether one organelle in the cell is more important than another. Relate cell parts to genetic disorders, (e. g., Lysosomes to Tay - Sachs disease).
- Use a variety of Internet sites to have students become familiar with mitosis and the follow-up computer lab on identification of the stages of mitosis.
- Have students use different power microscopes to study cells or microorganisms to experience how the type of technology can affect their conclusions. Arrangements might be made to take students to visit a place with an electron microscope or students could study pictures of cells or microorganisms taken with electron microscopes to draw conclusions.

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Matter, Energy and Organization in Living Systems

Essential Question*:*

- How do different organisms obtain and use energy to survive in their environment?

Core Content: Topics should include, but not be limited to:

- Chemical nature of photosynthesis
- Chemical nature of cellular respiration
- Relationship between of energy and matter in photosynthesis and respiration
- Importance of the ATP molecule
- Matter and energy as limiting factors in distribution and number of organisms
- Laws of conservation as matter and energy travel through organisms

Outcomes: By the end of twelfth grade students will be able to:

- Compare the processes of photosynthesis and cellular respiration.
- Relate the impact of Photosynthesis on climate change and environmental degradation.
- Describe how cells use ATP to do cellular work.

Assessment Strategies:

- Given the basic formula for photosynthesis, name the source of each molecule involved in the process.
- Explain why certain plants such as spider plants and philodendrons can reduce the amount of some pollutants like carbon monoxide (CO) or formaldehyde (CH_2O).
- Draw diagrams showing the relationships between photosynthesis and cellular respiration.
- Design experiments to show the effects of environmental factors (e.g. humidity, temperature, light levels) on the rates of photosynthesis.

Instructional Strategies:

- When teaching photosynthesis and cellular respiration have the students keep the "big picture" in mind. Work from the general to the specific.
- Have students find out more information about photosynthesis and cellular respiration by exploring the internet
- Explain the ATP cycle with the aid of power point slides and video clips.
- Using a prism, review the fact that white light is made up of various colors of the spectrum. Continue discussion on why we see things as different colors (reflected light). Relate this to the green color of chlorophyll. Also explain the presence of other pigments and their appearance in the colors of fall leaves.
- Using the microscope, have students observe the structure of stomates from several different types of leaves. A fresh cut leaf can be placed in water for about 30 minutes to show the formation of oxygen bubbles coming from the stomates.
- Differentiate between the amount of energy produced by cellular respiration and by fermentation. Have students compare the complexity of the end products. Where is most of the energy in products produced by fermentation?

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Reproduction and Heredity

Essential Questions:

- How is the hereditary information in genes inherited and expressed?
- How does DNA control growth and function of cells?

Core Content: Topics should include, but not be limited to:

- Meiosis (comparative study with mitosis)
- Chemical nature of nucleic acids (DNA and RNA)
- Relationship of structure to function of nucleic acids
- Protein synthesis: transcription and translation
- Mendelian genetics: terminology; analyze, predict and incorporate probability of various crosses.
- Human inheritance: human genome; types, disorders and mutations
- Genetic engineering: moral and ethical issues

Outcomes: By the end of twelfth grade students will be able to:

- Compare the sexual and asexual reproduction.
- Explain how DNA can replicate itself.
- Describe how DNA directs the sequence of amino acids in a protein.
- Discuss biotechnology applications.
- Describe how a variety of traits are inherited from generation to generation.

Assessment Strategies:

- Use DNA model kits to demonstrate the similarities and differences between mitosis and meiosis.
- Demonstrate how DNA stores information and how the code is deciphered.
- Using the Internet, produce a report on the International significance of the Human Genome Project. The project's benefits derived from the project could also be addressed in the report, as well as any controversial issues.
- Given a complex family marriage history, construct a pedigree chart demonstrating how various types of genetic disorders are passed from generation to generation.
- Conduct a debate on the pros and cons of various topics dealing with genetic engineering, cloning or other related genetic issues.

Instructional Strategies:

- Use the Internet to help students obtain the latest advances made on various human genetic disorders.
- Use YouTube presentations to help explain the process of protein synthesis.
- Provide students with the opportunity to work in groups to predict, solve and analyze Punnett square problems.
- Help students understand relationships between various genetic terminologies by having them construct a concept map using the terms studied.
- Show variations among human traits by having students measure and graph various body parts, e.g., *length of arms, fingers*. Have this lead into a discussion of multiple alleles and multiple genes. The results can also be used to study evolution and adaptation.
- Provide Case Studies or have students investigate examples of times when some scientists did not follow ethical procedures regarding genetic issues and the societal consequences of such actions.

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Evolution

Essential Question:

- How do we scientifically explain the evidence and mechanisms for biological evolution?

Core Content: Topics should include but not be limited to:

- Evidence of evolution
- Darwinian theory: how populations adapt (natural selection)
- Evolution as an on-going process: modern day examples
- How genetics applies to evolution
- Controversial issues surrounding evolution origin of life - age of the earth

Outcomes: By the end of twelfth grade students will be able to:

- Use Darwin's theory of Natural Selection to explain how species change over time
- Use microevolution to explain antibiotic resistance.
- Relate the change in gene frequencies at the population level result in speciation.
- Relate Natural Selection to extinction.

Assessment Strategies:

- Provide groups of students with a variety of fossils representing each of the four major eras in the history of life. Have each group develop a chronological timeline of the fossils and reasons for their choices. Hold follow up presentations and comparative discussions of each group's timeline.
- Research examples of modern evolution. (e.g.; antibiotic resistant bacteria) Relate to genetic principles and that evolution is an ongoing process.
- Using skeletons of various animals, do a comparative forelimb study. Relate structure to function and the evidence of homologous structures.
- Students can research and report on an historical scientific study and the social context in which the studies were conducted. One example is the text Voyage of the Beagle. Questions such as: "How did the investigation eventually influence society?" and "Were there any ethical issues that had to be addressed?" could be answered in the report.

Instructional Strategies:

- Do a pre-unit survey on student concepts of evolution.
- Hold discussions on the connection between genetic manipulation and evolution. (Oil consuming bacteria, drought resistant plants.) What are possible consequences?
    - Have students' research controversial issues surrounding the origin of life.
    - Briefly review Catholic Church documents regarding Evolution (see Introduction) and how behavioral responses evolved through natural selection.
- Investigate and report on courtship behavior or examples of territoriality and aggressive behavior in animals. Students should speculate on why these behaviors evolved.

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Interdependence of Organisms

Essential Questions*:*

- How do different organisms obtain and use energy to survive in their environment?
- How do organisms interact and depend on each other and their environment for survival?

Core Content: Topics should include but not be limited to:

- Interactions within a community: food webs, predator/prey adaptations, symbiosis
- Population growth analysis
- Ecological issues which impact interdependence of organisms: acid rain, global warming, ozone depletion
- Energy flow in ecosystems

Outcomes: By the end of twelfth grade students will be able to:

- Compare the roles of autotrophs, heterotrophs and decomposers in an ecosystem.
- Relate the Carbon, water and Nitrogen cycles to the transfer of matter through trophic levels.
- Describe the environmental impacts of a variety of human activities.

Assessment:

- Describe the difference between exponential and limited population growth.
- Fit different organisms into their “ecological niche” in a given habitat.
- Describe the three categories of symbiosis.
- Understand how humans have impacted the ecosystem both positively and negatively.

Instructional Strategies:

- Compare the flow of energy with the recycling of matter in ecosystems
- Use examples of Biomagnification and Bioaccumulation of pollutants in the environment
- Discuss the effects of habitat destruction and invasive species on endangered species

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Resources for Biology

Khan Academy https://www.khanacademy.org/science/
The Biology Project http://www.biology.arizona.edu/
Nobel Prize Interactive Games https://educationalgames.nobelprize.org/educational/
Bozeman Science http://www.bozemanscience.com/
Cell resources http://www.argosymedical.com/Cellular/index.html
Hippocampus https://www.hippocampus.org/Biology
Virtual microscope http://www.lab.anhb.uwa.edu.au/mb140/
HHMI BioInteractive Homepage | HHMI BioInteractive

CHEMISTRY

Secondary Level

National Standards and Benchmarks for Effective Catholic Secondary Schools

Domain: Mission and Catholic Identity; Standard 1

- *An excellent Catholic school is guided and driven by a clearly communicated mission that embraces a Catholic Identity rooted in Gospel values, Centered on the Eucharist, and committed to faith formation, academic excellence and service.*

Domain: Academic Excellence; Standard 7; Benchmark 7.2 &7.3

- *An excellent Catholic school has a clearly articulated, rigorous curriculum aligned with relevant standards, 21st century skills, and Gospel values, implemented through effective instruction.*
  - *Standards are adopted across the curriculum, and include integration of the religious, spiritual, moral, and ethical dimensions of learning in all subjects.*
  - *Curriculum and instruction for 21st century learning provide students with the knowledge, understanding and skills to become creative, reflective, literate, critical, and moral evaluators, problem solvers, decision makers, and socially responsible global citizens.*

Diocesan Outcomes:

- ***Through the study of the sciences, students will become thoughtful problem solvers***
- ***Students will utilize scientific skills to contribute to the solution of real world problems***
- ***Students will use the appropriate scientific models to describe and quantify the nature and interactions of matter and energy***
- ***Students will be able to discuss the scientific principles that are applicable to their everyday lives***
- ***Students will develop a respect for the study of the sciences***

"Raise your eyes and look about."

Isaiah 60:4

"Whenever we proceed from the known to the unknown we may hope to understand, but we may have to learn at the same time a new meaning of the word 'understanding'"

Werner Heisenberg

Overarching Essential Questions:

- ***How do scientists work to gather, analyze, communicate and validate data to form and change models?***
- ***How does matter undergo change?***
- ***How do matter and energy interact?***

Topics:

1. The Math of Chemistry

The metric system
Basic conversions in the metric system
Graphing with computers

2. Classification of Matter

Atomic differences between solids, liquids and gases
Differentiating between elements, compounds, homogeneous and heterogeneous mixtures

3. Atomic Structure

Identification of elements
Isotopes
Ions
Location of electrons
Impact of valance electrons on atomic reactivity

4. Periodic Table

Organization of the Periodic Table
Using the Periodic Table to predict properties of elements
Periodic Trends

5. Chemical Bonding, Formulas and Reactions

Names and formulas of ionic, molecular and acid compounds
Types of bonding that occur within and between various types of compounds
General types of chemical reactions and how to identify the type of reaction and predict products of a reaction

6. The Mole and Stoichiometry

The relationship between the mass of an atom or compound and the number of representative particles present
Percent by mass of an element in a compound
Determination of empirical and molecular formulas
Distinguish between the limiting and excess reactants
Using the given amount of Compound A, calculate the amount of Compound B required/produced
Calculate the Percent Yield of a chemical reaction

7. Kinetic Molecular Theory

Generalizations of physical properties for atoms and molecules in the gas phase
General relationships between pressure, volume and temperature
The Ideal Gas Law
Deviations from the Ideal Gas Law
Le Chatelier's Principle

8. Acids and Bases

Identify strong and weak acids and bases
Determination of pH or [H+] concentration
Determination pOH or [OH-] concentration
Auto-ionization Constant of water (Kw)
Relationship between Kw and acid and base dissociation constants (Ka and Kb, respectively)
Calculation of and use of Ka and Kb

Key Areas and Content

The Mathematics of Chemistry

Some specific mathematics skills that students in this course will have the opportunity to apply, and should be familiar with prior to beginning their study of Chemistry are:

- ***Construct and use tables and graphs to interpret data sets***
- ***Solve algebraic expressions and literal equations***
- ***Perform basic statistical procedures to analyze the center and spread of data***
- ***Measure with accuracy and precision (e.g., length, volume, mass, temperature, time)***
- ***Convert within a unit (e.g., centimeters to meters) using the factor label method***
- ***Use common prefixes such as milli-, centi-, and kilo-***
- ***Use scientific notation, where appropriate***
- ***Use ratio and proportion to solve problems***

The following skills will be addressed during the course and are necessary for a solid understanding in this course:

- ***Determine the correct number of significant figures.***
- ***Determine percent error from experimental and accepted values.***
- ***Use appropriate metric/standard international (SI) units of measurement for mass (g); length (cm); and time (s).***
- ***Use the Celsius and Kelvin scales.***

Essential Questions:

- Why does the way you measure and write down a number matter?
- What are significant figures and how/why are they used in scientific calculations?
- Why is the quoted number of significant figures matter when presenting chemical data?

Core Content: Topics should include, but not be limited to:

- Metric system
- Significant figures
- Dimensional analysis / factor-labeling

Core Content, continued:

- Scientific notation
- Graphing in Excel or equivalent
- Proper use of scientific calculators, especially use of the exponent button vs. $x10^n$

The following topics involving mathematics should be covered in the appropriate Key Areas:

- Balancing equations (Area 5)
- Molecular shapes (Area 5)
- Moles and mole equations (Area 6)
- Percent composition (Area 6)
- Stoichiometry (Area 6)
- Determining hydrogen ion concentration $[H^+]$ and pH (Area 8)

Outcomes: By the end of twelfth grade, students will be able to:

- Utilize the metric system, including conversions between units using dimensional analysis/factor-labeling
- Provide answers to the proper number of significant figures
- Proper use of scientific notation, including mathematic functions of addition, subtraction, multiplication and division
- Construct Excel graphs and provide the best fit line, the equation for that line and the linearity coefficient for the data.

Teacher Notes:

CLASSIFICATION OF MATTER

Essential Questions:

- How is matter classified?
- What is the difference between a physical / chemical property and / or change & what occurrences signify the type of change occurring in everyday processes?
- What are the names and symbols of common elements?

Core Content: Topics should include, but not be limited to:

- Elements, compounds, mixtures, and solutions
- Bonding and intermolecular forces of attraction
- Patterns in the periodic table including physical and chemical properties

Outcomes: By the end of twelfth grade, students will be able to:

- Account for the differences in the physical properties of solids, liquids and gases.
- Using examples, explain how physical properties may be used to separate a mixture.
- Predict the placement of unknown elements on the Periodic Table based on their physical and chemical properties.
- Describe the process by which solutes dissolve in solvents.

Teacher Notes:

ATOMIC STRUCTURE

Essential Questions:

- What is the interior structure of the atom and how was it experimentally determined?
- What are the structural & compositional difference between elements and compounds?

Core Content: Topics should include, but not be limited to:

- History of modern atomic theory
- Parts and properties of an atom
- Electron configuration of an atom
- Lewis (electron-dot) structures
- Fission and fusion reactions
- Radioactive isotopes

Outcomes: By the end of twelfth grade, students will be able to:

- Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outer most energy level of atoms
- Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay
- Explain the properties of isotopes, including half-lives, decay modes and nuclear resonances, lead to useful applications of isotopes.
- Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
- Use atomic models to predict the behaviors of atoms in interactions
- Model how the outermost electrons determine the reactivity of the elements and the nature of the chemical bonds they tend to form.

Teacher Notes:

Periodic Table

Essential Questions:

- How was the periodic table developed and how does it relate to the physical and chemical properties of elements?

Core Content: Topics should include, but not be limited to:

- Locations of s, p, d and f sublevels in the table
- Identifying the number of valance electrons for the Main Group elements
- General trends in periodic properties for the Main Group elements across the table, including:
    - atomic radii
    - ionic radii
    - ionization energy
    - electronegativity

Outcomes: By the end of twelfth grade, students will be able to:

- Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outer most energy level of atoms
- Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay
- Explain the properties of isotopes, including half-lives, decay modes and nuclear resonances, lead to useful applications of isotopes.
- Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
- Use atomic models to predict the behaviors of atoms in interactions
- Model how the outermost electrons determine the reactivity of the elements and the nature of the chemical bonds they tend to form.

***Teacher Notes*:**

Chemical Bonding, Formulas and Reactions

Essential Questions:

- Why do most atoms form chemical bonds?
- How can the position of elements on the Periodic Table be used to predict how they form compounds with other elements?
- How are ionic and covalent bonds formed, and how does the type of bond influence the properties of the compound?
- How do you name ionic and molecular compounds, and acids, and use their names to determine their chemical formulas?
- What are the Laws of Definite and Multiple Proportions?
- How are chemical equations balanced to satisfy the law of conservation of matter?
- What are 5 major types of chemical reactions and their identifying characteristics?
- How do you predict the products of common chemical reactions?

Core Content: Topics should include, but not be limited to:

- Naming ionic and molecular compounds, and acids, and write their chemical formulas
- Different types of chemical reactions
    - general types: synthesis/combination, decomposition, combustion, single replacement (oxidation/reduction), double
    - replacement (including acid/base)
- Factors affecting rates of reactions
    - temperature, particle size, reactant concentration(s), catalysts
- Properties of gases
- Law of Conservation of Mass in chemical reactions (balancing equations)
- Solubility
- Chemical equilibrium

Outcomes: By the end of twelfth grade, students will be able to:

- Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
- Account for any trends in the melting points and boiling points of various compounds
- Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

Outcomes, continued:

- Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium (Le Chatelier's Principle).
- Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
- Describe oxidation/reduction reactions, and give examples of oxidation and reduction reactions that have an impact on the environment, such as corrosion and the burning of fuel.
- Describe the potential commercial applications of endothermic and exothermic reactions.
- Describe the products and potential commercial application of fission and fusion reactions.
- Model the change in rate of a reaction by changing a factor.

***Teacher Notes*:**

The Mole and Stoichiometry

Essential Questions:

- How can scientists quantize the atoms and molecules that make up matter without being able to see them?
- Why is the mole an important measurement in chemistry?
- How can the amount of reactants and products necessary for a chemical reaction be predicted?
- What is the significance of a limiting reactant in stoichiometric calculations?

Core Content: Topics should include, but not be limited to:

- Describe how the use of the mole simplifies chemical calculations.
- Determine the number of grams, moles and/or representative particles in a sample of an atom or compound.
- Use percent by mass (percent composition) to determine empirical formula.
- Deduce the molecular formula of a compound from its empirical formula and molecular mass.
- Identify mole ratios through the use of balanced chemical equations
- Employ the appropriate mole calculations and mole ratio to derive the unknown amount of a compound.

Outcomes: By the end of twelfth grade, students will be able to:

- Employ the appropriate mole calculations and mole ratio to derive the unknown amount of a compound.
- Describe how the use of the mole simplifies chemical calculations.
- Determine the number of grams, moles and representative particles of an atom or compound.
- Use percent by mass to determine empirical formula.
- Deduce the molecular formula from the empirical formula and molecular mass.
- Employ the balanced chemical equation to identify mole ratios.
- Derive the unknown amount of a compound using the appropriate mole calculations and mole ratio(s)

***Teacher Notes*:**

Kinetic Molecular Theory

Essential Questions:

- How do gases respond to changes in temperature, pressure and volume?
- Why is the idea of an ideal gas useful even though ideal gases do not really exist?
- How does the behavior of atoms and molecules determine the physical properties of solids, liquids, and gases?
- How are gases different from solids and liquids and why do they exhibit "ideal behavior?"
- What factors influence the behavior of gases and what are the mathematical relationships between them?

Core Content: Topics should include, but not be limited to:

- The basic Kinetic Molecular Theory (KMT) postulates:
  - atoms/molecules are considered points in space
  - totally elastic collisions, so total kinetic energy is conserved
  - gas particles exhibit constant, random, straight-line motion
  - no significant intermolecular interactions occur between gas particles
- Boyle's Law – volume is inversely proportional to pressure
- Charles' Law – volume is directly proportional to temperature
- Dalton's Law of Partial Pressures – the total pressure is the sum of the partial pressures
- Avogadro's Law – volume is proportional to the number of particles (moles)
- Effusion versus Diffusion
- Application of KMT to the solid and liquid states

Outcomes: By the end of twelfth grade, students will be able to:

- Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
- Use Kinetic Molecular Theory to describe and explain the properties of solids, liquids and gases.
- Understand the assumptions implicit in the Ideal Gas Law and describe how they allow the successful application of the Ideal Gas Law.
- Describe the conditions where the Ideal Gas Law is violated, and how this occurs, using Kinetic Molecular Theory.
- Describe the effect of changing conditions on the position of a chemical equilibrium, using Le Chatelier's Principle.

***Teacher Notes*:**

Acids and Bases

Essential Questions:

- What gives acids and bases their particular characteristics and properties?
- Why are there so many different definitions of acids?
- Where does pH play a role in your everyday lives?

Core Content: Topics should include, but not be limited to:

- Acids and Bases in aqueous solution
- Auto-ionization Constant of water (Kw) and the pH scale
- Proton transfer
- Molecular properties and acid strength
- Determination of pH or H^+ concentration $[H^+]$
- Determination pOH or OH^- concentration $[OH^-]$
- Relationship between Kw and acid and base dissociation constants (Ka and Kb, respectively)
- Solving problems involving weak acid equilibria
- Weak bases and their relationship to weak acids

Outcomes: By the end of twelfth grade, students will be able to:

- Understand the differences between strong acids/bases and weak acids/bases.
- Employ pH to calculate the concentration of hydrogen or hydroxide ion ($[H^+]$ and $[OH^-]$, respectively).
- Determine the volume or concentration of an acid required to neutralize a known volume and concentration of acid, and vice- versa.

Teacher Notes:

Resources for Chemistry

Tutorial/ Instruction

The Organic Chemistry Tutor- https://www.youtube.com/channel/UCEWpbFLzoYGPfuWUMFPSaoA

Khan Academy- https://www.khanacademy.org/science/chemistry

PhET Simulations- https://phet.colorado.edu/en/simulations/category/chemistry

ACS Virtual Chemistry and Simulations- https://www.acs.org/content/acs/en/education/students/highschool/chemistryclubs/activities/simulations.html

Chemistry LibreTexts- https://chem.libretexts.org/Ancillary_Materials/Interactive_Applications

Videos

EdPuzzle- https://edpuzzle.com/

Science 360- https://science360.gov/topic/Chemistry%20&%20Materials/

Veritasium- https://www.youtube.com/channel/UCHnyfMqiRRG1u-2MsSQLbXA

Additional Resources

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Chemistry Section Comments

PHYSICS

Secondary Level

National Standards and Benchmarks for Effective Catholic Secondary Schools

Domain: Mission and Catholic Identity; Standard 1

- *An excellent Catholic school is guided and driven by a clearly communicated mission that embraces a Catholic Identity rooted in Gospel values, Centered on the Eucharist, and committed to faith formation, academic excellence and service.*

Domain: Academic Excellence; Standard 7; Benchmark 7.2 &7.3

- *An excellent Catholic school has a clearly articulated, rigorous curriculum aligned with relevant standards, 21st century skills, and Gospel values, implemented through effective instruction.*
  - *Standards are adopted across the curriculum, and include integration of the religious, spiritual, moral, and ethical dimensions of learning in all subjects.*
  - *Curriculum and instruction for 21st century learning provide students with the knowledge, understanding and skills to become creative, reflective, literate, critical, and moral evaluators, problem solvers, decision makers, and socially responsible global citizens.*

Diocesan Outcomes:

- ***Through the study of the sciences, students will become thoughtful problem solvers***
- ***Students will utilize scientific skills to contribute to the solution of real world problems***
- ***Students will use the appropriate scientific models to describe and quantify the nature and interactions of matter and energy***
- ***Students will be able to discuss the scientific principles that are applicable to their everyday lives***
- ***Students will develop a respect for the study of the sciences***

Overarching Essential Questions:

- ***How does physics serve to improve our understanding of physical systems?***
- ***How do the principles of physics effect our daily lives?***
- ***How do matter and energy interact?***

"Gravity explains the motions of the planets, but it cannot explain who sets the planets in motion."

-Isaac Newton

Topics:

1. **The Math in Physics**

Measurement	*Dimensional/ Unit Analysis*	*Problem Solving*
SI System	*Vector Analysis*	*Use of a Scientific Calculator*
Significant Figures	*Graphing*	

2. **Kinematics**

Displacement, velocity and acceleration	*One-dimensional motion*	*Two-dimensional motion*
	Kinematic equations	*Projectile motion*
Circular motion	*Universal Gravitation*	

3. **Dynamics**

Forces	*Newton's Laws of Motion*	*Equilibrium*
Free-body diagrams	*Friction*	

4. **Work and Energy**

Work	*Elastic Potential Energy*	*Power*
Kinetic Energy	*Work-Energy Theorem*	*Energy Transformations*
Gravitational Potential Energy	*Conservation of Energy*	*Simple Machines*

5. **Momentum**

Single-object Momentum	*Conservation of Momentum*
Impulse-Momentum Theorem	*Collisions*

6. Waves, Sound and Light

Characteristics of Waves
Wave Motion
Types of Waves
Doppler Effect
Sound Intensity
Standing Waves
Electromagnetic Spectrum
Reflection and Refraction
Mirrors and Lenses

7. Electricity and Magnetism

Electric Charge
Electric Fields
Electric Force
Electrical Energy and Current
Circuits
Magnetic Fields
Magnetic Force
Magnetic Induction
Electromagnetic Induction
Generators and Motors

8. Fluid Mechanics/ Heat*

Phases of Matter
Pressure in Fluids
Buoyancy
Bernoulli's Equation
Heat and Temperature
Heat Transfer
Kinetic Theory
Thermal Expansion
Conservation of Heat
Specific Heat Laws of Thermodynamics

** May be omitted due to time constraints*

Key Areas and Content

The Math of Physics

Some specific mathematics skills that students in this course will have the opportunity to apply, and should be familiar with prior to beginning their study of Physics are:

- ***Construct and use tables and graphs to interpret data sets***
- ***Solve algebraic expressions and literal equations***
- ***Perform basic statistical procedures to analyze the center and spread of data***
- ***Measure with accuracy and precision (e.g., length, volume, mass, temperature, time)***
- ***Convert within a unit (e.g., centimeters to meters) using the factor label method***
- ***Use common prefixes such as milli-, centi-, and kilo-***
- ***Use scientific notation, where appropriate***
- ***Use ratio and proportion to solve problems***

Essential Questions:

- How do we select a strategy or method to solve problems?
- How do we apply prior knowledge to solving physics problems?
- Why is a fundamental understanding of how to properly take measurements in the world around us and make calculations based on those measurements useful in both Physics and everyday life?
- How will an understanding of basic algebraic functions, order of operations, scientific notation and trigonometry help in understanding the motion of objects and Physics in general?
- What are the clues that the quantity being measured is a vector or scalar, and why does that distinction matter?
- How do vector and scalar quantities differ from each other, and in what way do calculations with each quantity differ from each other?
- How can graphing relationships lead to an understanding of the nature of the relationship, what useful information can be drawn from graphical relationships and how can we use graphs to predict the behavior of things we measure? When is making such predictions appropriate or inappropriate? How confident can we be of those predictions?

Core Content: Topics should include, but not be limited to:

- Problem Solving
- Measurement/ SI System
- Scientific Notation
- Significant Figures
- Dimensional/Unit Analysis
- Vector Analysis
- Graphing

Outcomes: By the end of twelfth grade, students will be able to:

- Utilize multi-representational problem-solving skills to formulate solutions to complex problems
- Understand the relationship among words, equations and graphs
- Understand that science involves finding patterns to develop
- Utilize a scientific calculator to carry out mathematical analysis of complex problems
- Apply dimensional / unit analysis to solve problems
- Define and use basic trigonometric functions to solve right triangle problems
- Define and utilize base and derived units in the SI system including common metric prefixes and nonstandard metric units
- Recognize the symbols that accompany the physical quantities and units of measurements
- Apply accuracy and precision when measuring
- Translate numbers in and out of scientific notation
- Carry out calculations with numbers in scientific notation
- Utilize significant figures to report the proper number of significant figures after performing simple calculations
- Explain conversion-factor relationships and apply them in converting units within a system or from one system of units to another
- Define vector and scalar, incorporating magnitude and direction
- Understand vector notation and be able to add and subtract vectors graphically and analytically
- Show that vectors may be broken down into perpendicular components
- Demonstrate that vector components may be added to determine resultant vectors
- Create graphs using graphing software, as well as, hand drawn graphs
- Utilize graphing software (e.g., Excel or Logger Pro) to analyze graphs

Outcomes, continued:

- Define basic mathematical relationships (direct, inverse, and exponential), describe the graphs of these relationships and how to calculate the line of best fit for each relationship

Teacher Notes:

Kinematics

Essential Questions:

- On what factors does the rate of motion of an object depend?
- How do we know whether something is moving?
- How is motion measured?
- How is motion visualized and analyzed graphically?
- How is the motion of an object affected by the vantage point (reference frame) of the observer?
- How can understanding various physical properties about motion be useful in understanding everyday occurrences?
- What variables can you manipulate to affect the movement of objects?

Core Content: Topics should include, but not be limited to:

- Displacement, velocity and acceleration
- One dimensional motion
- Kinematic equations
- Motion graphs
- Two dimensional motion
- Projectile motion
- Circular motion
- Universal Gravitation

Outcomes: By the end of twelfth grade, students will be able to:

- Understand that the principles of mechanics can describe the motion of all objects
- Develop the definition of velocity as the rate of change of position conceptually, mathematically and graphically
- Differentiate speed from velocity, define acceleration in terms of velocity
- Apply the qualitative definition of acceleration to determine if an object is accelerating
- Apply concepts of speed, velocity and acceleration to solve conceptual and quantitative problems and report answers in correct units

Outcomes, continued:

- Recognize that all motion is described relative to a frame of reference and describe how "relative" changes as the reference frame changes
- Use multiple representations of one dimensional motion to analyze and make predictions about the motion of a system
- Explain the kinematic equations of constant acceleration and apply them to physical systems
- Determine velocity by taking the slope of a position-time graph, and determine acceleration from the slope of a velocity-time graph, as well as the displacement by calculating the area under the curve.
- Solve multi-step problems in both one and two dimensions
- Use vectors to describe motion in two dimensions including relative velocity
- Analyze two-dimensional motion in terms of its components and apply the kinematic equations to components of motion
- Recognize that the vertical and horizontal motions of a projectile are independent
- Relate maximum height, the time to reach maximum height, time in the air, and range to the initial horizontal and vertical velocity of the projectile; solve related projectile motion problems for these values independently
- Understand factors affecting circular motion
- Define period of motion, frequency of motion
- Explain how the presence of centripetal force produces a circular motion
- Describe the direction of a particle's velocity and acceleration at any point during the motion
- Define gravity and explain the nature of gravity
- Analyze Newton's Law of Universal Gravitation and predict changes in m, m_2, and d
- Demonstrate an ability to use Newton's Law of Universal Gravitation to solve for forces between objects
- State and explain Kepler's laws of planetary motion and describe the orbits and motions of satellites

Teacher Notes:

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Dynamics

Essential Questions:

- How do forces cause and effect motion?
- What situations can be explained by our knowledge of forces?
- What is the relationship between force and motion?

Core Content: Topics should include, but not be limited to:

- Forces
- Free-body diagrams
- Net force
- Newton's Laws of Motion
- Friction
- Equilibrium

Outcomes: By the end of twelfth grade, students will be able to:

- Relate force and motion and explain what is meant by a net or unbalanced force
- Identify the type and relative magnitude of the individual forces that act upon an object and to use such information to construct free-body diagrams for a physical situation
- Describe inertia using Newton's First Law of Motion
- Apply the concept of inertia to determine the motion of an object experiencing a force
- Define mass in terms of inertia
- Describe how the weight and mass of an object are related
- Relate force, mass and acceleration using Newton's Second Law of Motion
- Apply Newton's laws in analyzing various situations using free-body diagrams
- Analyze and predict changes in the motion of a system
- Analyze variables that effect the force between two objects
- Apply Newton's Laws of Motion to analyze the motion of systems

Outcomes, continued:

- Define free fall and air resistance, calculate distance traveled during free fall using average velocity, state speed and acceleration of objects at various positions during free fall
- State and explain Newton's Third Law, identify action/reaction pairs, explain why an action does not cancel out a reaction.
- Explain the implications of Newton's Third Law on daily life
- Distinguish between static and kinetic friction
- Solve quantitative problems with frictional forces, applying the coefficient of friction
- Solve quantitative problems with normal forces, tensions and friction forces in solving problems in one and two dimensions
- Solve quantitative problems relative to an object's motion on an incline plane in both equilibrium and non-equilibrium situations

Teacher Notes:

Work and Energy

Essential Questions:

- How do you know something has energy?
- In what ways do we witness the effects of something having energy?
- How can the law of conservation of energy be used to solve problems?
- How do real-world situations prove the law of conservation of energy?
- How do simple machines make work easier?

Core Content: Topics should include, but not be limited to:

- Work
- Kinetic energy
- Gravitational potential energy
- Elastic potential energy
- Work-energy theorem
- Conservation of Energy
- Power
- Energy Transformations
- Simple Machines

Outcomes: By the end of twelfth grade, students will be able to:

- Describe the concept of work as force applied over a distance
- Compute the work done in various situations, including work done by a spring force
- Calculate the change in kinetic energy as a result of a specific amount of work performed on an object
- Calculate the potential energy of one or more objects in a uniform gravitational field
- Apply proportional reasoning to the relationship between a spring's potential energy and its deformation
- Differentiate between kinetic energy, potential energy and elastic potential energy
- Use the work-energy theorem to determine changes in energy of a system
- Distinguish between conservative and nonconservative forces and explain their effects on the Conservation of Energy

Outcomes, continued:

- Describe the Law of Conservation of Energy, the implications of this law in everyday life and apply this law to solving problems
- Differentiate between work and power and demonstrate an ability to calculate power
- Understand that interrelationship between work and power in terms of force applied horizontally or vertically
- Represent energy in multiple ways to analyze and or predict physical phenomena in terms of energy transformations and transfers in a system
- Use multiple representations to discuss energy and energy transfer
- Discuss the implications of energy laws to our world economy and future challenges regarding energy supplies
- Demonstrate the use of simple machines in performing work
- Describe the concept of efficiency; calculate the efficiency of simple machines
- Describe the concept of mechanical advantage
- Demonstrate how inclined planes provide a mechanical advantage

Teacher Notes:

Momentum

Essential Questions:

- How is it determined that momentum is conserved for an isolated system?
- How does an impulse change the momentum of a system?
- How can the changes in the motion of an object be described using momentum and impulse?

Core Content: Topics should include, but not be limited to:

- Single-object momentum
- Impulse-momentum Theorem
- Conservation of Momentum
- Elastic and Inelastic collisions

Outcomes: By the end of twelfth grade, students will be able to:

- Define momentum using P = mv
- Compute momentum and the components of momentum
- Use multiple representations to justify and/or predict changes in momentum within and between systems and the surrounding environment
- Relate impulse and momentum and kinetic energy and momentum
- Distinguish between impulse and force
- Analyze real world applications of impulse and momentum
- Understand the relationship between physical quantities related to impulse and momentum
- Apply Conservation of Momentum to problems in one dimension
- Explain the condition for the conservation of linear momentum and apply them to physical situations
- Describe the conditions of kinetic energy and momentum in elastic and inelastic collisions
- Explain the concept of the center of mass and compute its location for simple systems
- Describe how the center of mass and center of gravity are related

Teacher Notes:

Waves, Sound and Light

Essential Questions:

- Describe everyday occurrences of vibrating systems. What is the frequency of vibration in each system you described? How do know that vibrations carry energy?
- Where do waves come from?
- How do you know that waves carry energy?
- How do the properties of EM waves determine their uses?
- What determines the colors you see in nature?
- Why are optical fibers preferred over electrical cables to send information?

Core Content: Topics should include, but not be limited to:

- Simple harmonic motion (SHM)
- Characteristics of waves
- Wave motion
- Types of waves
- Frequency, pitch and volume
- Doppler Effect
- Electromagnetic spectrum
- Color- light vs. pigment
- Reflection, Refraction and Diffraction
- Optics

Outcomes: By the end of twelfth grade, students will be able to:

Simple Harmonic Motion

- Apply concepts of SHM to predict motion
- Analyze representations of period, frequency, amplitude, restoring force and acceleration
- Formulate solutions to problems involving Hooke's Law, energy, and period of a spring or pendulum
- Analyze data to prove which variables affect the period of oscillation for a spring or pendulum
- Prove how the concepts of kinematics, dynamics, and energy relate to SHM
- Construct graphs of an object in SHM

Outcomes, continued:

Waves

- Perform calculations to find period, frequency, and wavelength of a wave
- Differentiate between transverse and longitudinal waves
- Predict how waves behave when interacting with barriers and other waves
- Compare and contrast waves in and out of phase
- Define standing waves and identify nodes and antinodes

Sound

- Discuss Doppler effect in terms of wavelength
- Apply Doppler effect to real life situations
- Define and give examples of resonance
- State the effects of constructive and destructive interference of sound waves
- Explain how beats happen in terms of interference
- Differentiate between frequency, pitch, volume and intensity, tonality and timbre in harmonics
- Recognize the parts of the ear responsible for hearing

Light

- Recognize that light is the visible portion of an entire range of electromagnetic frequencies
- Solve basic problems involving the speed of light
- Explain the formation of color by light and by pigments or dyes
- Describe polarization, methods of production and uses of polarized light
- Relate frequency and wavelength for visible light
- Describe and apply the law of reflection
- Calculate the index of refraction of a medium and solve basic index of refraction/speed of light problems
- Define Snell's Law and show how the law may be applied to solve basic refraction problems

Optics

- Explain how concave, convex and plane mirrors form images
- Locate images using ray diagrams and define images as real or virtual
- Use mirror/lens laws to calculate image locations, magnifications and orientations for converging and diverging lenses

Teacher Notes:

Electricity and Magnetism

Essential Questions:

- How can charged particles, the electric fields they produce and the interaction between those fields be represented verbally, graphically and mathematically?
- How do we receive electricity in our homes?
- What physical principles is this based on?
- In what ways are the gravitational and electric forces similar?
- How are electricity and magnetism related to one another?
- What effect does electromagnetism have on everyday life?

Core Content: Topics should include, but not be limited to:

- Electric charge
- Coulomb's Law
- Electric field
- Electrical energy and current
- Circuits
- Magnetic fields
- Magnetic force
- Magnetic induction
- Electromagnetic induction
- Generators and motors

Outcomes: By the end of twelfth grade, students will be able to:

Electricity

- Understand the basic principles of electric charges and the subatomic particles associated with them.
- Determine the net charge on a particle or object.
- Distinguish between charging through contact, polarization and induction.
- Identify interactions between particles and objects possessing similar and different electric charges.
- Distinguish between conductors and insulators.
- Develop models to represent charges distributed in conductors and insulator.

Outcomes, continued:

Electricity

- Calculate electric force using Coulomb's Law
- Understand the relationship between charge and distance of the charges in Coulomb's Law
- Create free body diagrams showing forces acting on a charged particle by other charged particles in the system
- Solve problems relating to charge, electric field and force.
- Diagram electric field lines
- Use Ohm’s Law to calculate voltage, current, and resistance.
- Predict the change in current based on changes in voltage and resistance.
- Differentiate between electrical potential energy, potential difference, and voltage.
- Formulate solutions to problems involving electricity, Ohm's law and electrical power
- Compare and contrast gravitational force with electric force, including how mass interactions are analogous to charge interactions.
- Identify the components of a circuit
- Differentiate between circuits (series, parallel, combination)
- Draw a schematic of simple series, parallel and combination circuits.
- Apply Ohm’s Law to simple series, parallel, and combination circuits.

Magnetism

- Draw the magnetic field lines surrounding different configurations of bar magnets
- Interpret magnetic field lined for magnets and magnetic materials
- Use right-hand rules to predict directions of moving charges, magnetic fields and magnetic force
- Relate magnetic currents and magnetic fields
- Identify magnetic materials and determine if an object is a magnet, magnetic, or nonmagnetic
- Predict the relative strength of an electromagnet based on the current passing through the wire
- Explain how an electromagnet works
- Explain electromagnetic induction
- Apply concepts associated with electromagnetism to solve advanced problems
- Apply the relationship between electric fields and magnetic fields to real-world problems

Teacher Notes:

Fluid Mechanics/Heat

Essential Questions:

- Why is knowledge of fluids essential for efficient travel by ground, sea and air?
- Why can our perception of temperature be subjective?
- How does the temperature of water impact its ability to act as an effective solvent?

Core Content: Topics should include, but not be limited to:

- Thermal energy
- First and Second Law of Thermodynamics
- Bernoulli's Equation
- Pascal's principle
- Archimedes' principle
- Kinetic Molecular Theory

Outcomes: By the end of twelfth grade, students will be able to:

- Describe thermal energy and compare it to potential and kinetic energies
- Distinguish between heat, temperature and thermal energy
- Explain how the temperature scale is constructed and convert temperatures from one scale to another
- Define specific heat and explain how the specific heats of materials are measured using the technique of calorimetry
- Define heats of fusion and vaporization
- Calculate heat transfer
- State the first and second laws of thermodynamics
- Use Bernoulli's equation to make calculations related to a moving fluid
- Calculate the pressure-depth relationship and state Pascal's principle and describe how it is used in practical applications
- Relate the buoyant force to Archimedes' principle and tell whether an object will float in a fluid on the basis of relative densities
- Describe the ideal gas law, explain how it is used to determine absolute zero and understand the Kelvin temperature scale
- Utilize gas laws to determine changes in pressure, temperature and volume
- Relate kinetic theory and temperature

Teacher Notes:

Resources for Physics

Tutorial/ Instruction

The Physics Classroom- https://www.physicsclassroom.com/

Khan Academy- https://www.khanacademy.org/science/physics

PhET Simulations- https://phet.colorado.edu/en/simulations/category/physics

HyperPhysics- http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

Videos

Flipping Physics- https://www.flippingphysics.com/algebra.html

EdPuzzle- https://edpuzzle.com/

Science 360- https://science360.gov/files/

The Mechanical Universe- http://www.infocobuild.com/education/learn-through-videos/physics/TheMechanicalUniverse/lecture-01.html

Veritasium- https://www.youtube.com/channel/UCHnyfMqiRRG1u-2MsSQLbXA

Additional Resources