Davison Community Schools
ADVISORY CURRICULUM COUNCIL
Phase II
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Honors Physical Science 9

Course Essential Questions (from Phase I report):
How does matter and energy interact and affect the world we live in?

Phase II Curriculum

Unit: The Nature of Science

Essential Questions:	**Essential Understanding:**
1. How do Scientists analyze and interpret evidence to solve problems and make decisions? 2. What method(s) do scientists use to gather and interpret data in order to form a conclusion about an experiment? 3. How should a scientist research a problem?	1. Scientists analyze and interpret evidence to solve problems and make decisions. 2. Scientists gather, classify, sequence, and interpret information and visual data in order to recognize how organisms, places, and events shape our world. 3. Scientists make inferences and generalizations about various types of information and draw conclusions from a variety of sources.

Curriculum Standards- DOK noted where applicable with Standards

P1.1A Generate new questions that can be investigated in the laboratory or field. (DOK 3)
P1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions. (DOK 3)
P1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity–length, volume, weight, time interval, temperature–with the appropriate level of precision). (DOK 2)
P1.1D Identify patterns in data and relate them to theoretical models.(DOK 2)
P1.1E Describe a reason for a given conclusion using evidence from an investigation.(DOK 3)
P1.1f Predict what would happen if the variables, methods, or timing of an investigation were changed.(DOK 3)
P1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.(DOK 3)
P1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.(DOK 3)
P1.1i Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.(DOK 3)
P1.2A Critique whether or not specific questions can be answered through scientific investigations(DOK 3)

P1.2h Describe the distinctions between scientific theories, laws, hypotheses, and observations.(DOK 2)
P1.2i Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.(DOK 2)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. How to identify problems, plan experiments, record observations,and correctly report data 2. Scientists use standard units of measure that together form the International System of Units, or SI. 3. Natural science is divided into biological science, physical science and Earth science. 4. Theories explain why something happens, laws explain how something works. 5. How and when to report data as a line graph, bar graph or pie graph. 6. To reduce the number of zeros in very big and very small numbers, you can express the values as simple numbers multiplied by a power of 10, a method called scientific notation. 7. How to use significant figures to show the precision of a measured quantity. **The following vocabulary words:** 8. science is the the knowledge obtained by observing natural events and conditions in order to discover facts and formulate laws or principles that can be verified or tested. 9. technology is the the application of science for practical purposes. 10. a scientific law is a descriptive statement of equation that reliably predicts events under certain conditions. 11. a scientific theory is a system of ideas that explains many related observations and is supported by a large body of evidence acquired through scientific investigation. 12. the scientific method is a series of steps followed to solve problems including collecting data, formulating a hypothesis, testing the hypothesis, and stating conclusions. 13. a hypothesis is a possible explanation or answer that can be tested – Scientists test a hypothesis by doing a controlled experiment. 14. a variable is a factor that changes in an experiment in order to test a Hypothesis.	1. think and act like a scientist 2. measure things scientifically 3. explore the world using scientific processes (the scientific method) 4. organize things scientifically **5.** determine what are scientific theories, and differentiate them from scientific laws 6. organize data in a scientific manner 7. use scientific notation correctly in various math functions 8. determine the precision of a measuring instrument

15. precision is the exactness of a measurement. 16. accuracy is a description of how close a measurement is to the true value of the quantity measured. 17. significant figure is a prescribed decimal place that determines the amount of rounding off to be done. It is based on the precision of the measurement and the instrument used.	

Phase II Curriculum

Unit: Motion

Essential Questions:	**Essential Understanding:**
● Describe and represent various types of motion ● Describe the relationships between position and time using mathematical statements, graphs, and motion maps ● Identify different interactions that exist between objects using the concept of force. ● How acceleration, time, and velocity are related? ● Explain how positive and negative acceleration affect motion. ● How do you calculate the acceleration of an object? ● Explain how force and motion are related. ● Describe what inertia is and how it is related to Newton's first law of motion. ● Identify the forces and motion that are present during a car crash.	● The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time. ● An object's position can be measured and graphed as a function of time. An object's speed can be calculated and graphed as a function of time. ● The change of speed and/or direction (acceleration) of an object is proportional to the net force and inversely proportional to the mass of the object. The acceleration and net force are always in the same direction. ● Forces have magnitude and direction. The net force on an object is the sum of all the forces acting on the object. Objects change their speed and/or direction only when a net force is applied. If the net force on an object is zero, there is no change in motion (Newton's First Law). ● There are four basic forces (gravitational, electromagnetic, strong, and weak nuclear) that differ greatly in magnitude and range. ● Between any two charged particles, electric force is vastly greater than the gravitational force. ● Most observable forces (e.g., those exerted by a coiled spring or friction) may be traced to electric forces acting between atoms and molecules.

Curriculum Standards- DOK noted where applicable with Standards

P2.1A Calculate the average speed of an object using the change of position and elapsed time;(DOK 1)
P2.1C Create line graphs using measured values of position and elapsed time;(DOK 2)
P2.1D Describe and analyze the motion that a position-time graph represents, given the graph;(DOK 2)
P2.1g Solve problems involving average speed and constant acceleration in one dimension;(DOK 1)
P2.3a Describe and compare the motion of an object using different reference frames;(DOK 2)
P1.2B Identify and critique arguments about personal or societal issues based on scientific evidence;(DOK 3)
P1.2f Critique solutions to problems, given criteria and scientific constraints;(DOK 3)
P2.1h Identify the changes in speed and direction in everyday examples of circular, periodic, and projectile motions;(DOK 1)
P2.2A Distinguish between the variables of distance, displacement, speed, velocity, and acceleration;(DOK 1)

P2.2B Use the change of speed and elapsed time to calculate the average acceleration for linear motion;(DOK 1)
P2.2C Describe and analyze the motion that a velocity-time graph represents, given the graph;(DOK 2)
P2.2D State that uniform circular motion involves acceleration without a change in speed;(DOK 1)
P3.4D Identify the force(s) acting on objects moving with uniform circular motion.(DOK 1)
P2.2e Use the area under a velocity-time graph to calculate the distance traveled and the slope to calculate the acceleration;(DOK 2)
P2.3a Describe and compare the motion of an object using different reference frames;(DOK 2)
P3.1A Identify the force(s) acting between objects in "direct contact" or at a distance;(DOK 1)
P3.1b Explain why scientists can ignore the gravitational force when measuring the net force between two electrons;(DOK 1)
P3.1c Provide examples that illustrate the importance of the electric force in everyday life;(DOK 1)
P3.1d Identify the basic forces in everyday interactions;(DOK 1)
P3.2A Identify the magnitude and direction of everyday forces;(DOK 1)
P3.2C Calculate the net force acting on an object;(DOK 1)
P3.4A Predict the change in motion of an object acted on by several forces.(DOK 2)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. When an object changes position with respect to a frame of reference, the object is in motion. 2. Speed tells us how fast an object moves, and velocity tells us both the speed and the direction that the object moves. 3. To calculate speed, you must measure two quantities: the distance traveled and the time it took to travel that distance. 4. You can plot a graph showing distance on the vertical axis and time on the horizontal axis. 5. When an object undergoes acceleration, its velocity changes. 6. The average acceleration over a given time interval can be calculated by dividing the change in the object's velocity by the time over which the change occurs. 7. The slope of a straight line on a speed vs. time graph is equal to the acceleration. 8. The fundamental forces of nature forces are the force of gravity, the electromagnetic force, the strong nuclear force, and the weak nuclear force. 9. Whenever there is a net force acting on an object, the object accelerates in the direction of the net force. 10. The force of friction always opposes the motion. 11. Friction is necessary for many everyday tasks	1. Use a frame of reference to describe the motion of an object 2. determine the difference between speed and velocity 3. calculate the speed of an object given the distance and time 4. Measure the speed of an object by using a graph,s slope 5. Determine what changes when an object accelerates 6. Calculate the acceleration of an object moving in a straight line 7. Measure the acceleration of an object using a distance/time graph 8. Identify as the fundamental forces of nature 9. Determine what will happen when there is a net force acting on an object 10. measure the force of friction and evaluate its effect on acceleration 11. Explain why is friction sometimes necessary

to work correctly.

The following vocabulary words:

12. motion: an object's change in position relative to a reference point
13. frame of reference: a system for specifying the precise location of objects in space and time
14. speed: the distance traveled divided by the time interval during which the motion occurred.
15. velocity: the speed of an object in a particular direction
16. Constant speed: equal distances in equal amounts of time
17. Instantaneous speed: the speed at a given time
18. acceleration: the rate at which velocity changes over time; an object accelerates if its speed, direction, or both change
19. net force: the combination of all forces acting on an object
20. friction: a force that opposes motion between two surfaces that are in contact
21. static friction: the force that resists the initiation of sliding motion between two surfaces that are in contact and at rest
22. sliding friction: when objects slide past each other
23. rolling friction: when a rounded object rolls over a flat surface

Phase II Curriculum

Unit: Forces

Essential Questions:	**Essential Understanding:**
● What is Newton's Second Law of Motion? ● Apply Newton's Second Law of Motion. ● What are the three different types of friction. ● How does air resistance affect falling objects? ● What is a gravitational force? ● What is the difference between mass and weight? ● Why do thrown objects follow a curved path? ● What is the difference between circular motion and straight line motion. ● What is Newton's Third Law of Motion? ● What are action and reaction forces? ● How do you calculate momentum? ● When is momentum conserved?	● Newton's Laws of Motion connect the change in an objects motion with the forces acting on it. ● The acceleration of an object equals the net force divided by the mass. ● Gravity is an attractive force that any two objects with mass exert on each other. ● Forces between two objects are always exerted in pairs.

Curriculum Standards- DOK noted where applicable with Standards

P1.2B Identify and critique arguments about personal or societal issues based on scientific evidence;(DOK 3
P1.2f Critique solutions to problems, given criteria and scientific constraints;(DOK 3)
P1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions;(DOK 2)
P2.1E Describe and classify various motions in a plane as one dimensional, two dimensional, circular, or periodic; (DOK 2)
P2.1h Identify the changes in speed and direction in everyday examples of circular, periodic, and projectile motions; (DOK 1)
P2.2g Apply the independence of the vertical and horizontal initial velocities to solve projectile motion problems;(DOK 2)
P3.2A Identify the magnitude and direction of everyday forces;(DOK 1)
P3.3A Identify the action and reaction force from examples of forces in everyday situations;(DOK 1)
P3.3b Predict how the change in velocity of a small mass compares to the change in velocity of a large mass when the objects interact;(DOK 2)
P3.3c Explain the recoil of a projectile launcher in terms of forces and masses;(DOK 1)
P3.3d Analyze why seat belts may be more important in autos than in buses;(DOK 2)
P3.4A Predict the change in motion of an object acted on by several forces;(DOK 2)
P3.4B Identify forces acting on objects moving with constant velocity;(DOK 1)
P3.4C Solve problems involving force, mass, and acceleration in linear motion;(DOK 1)
P3.4e Solve problems involving force, mass, and acceleration in two-dimensional projectile motion restricted to an initial horizontal velocity with no initial vertical velocity;(DOK 1)
P3.4f Calculate the changes in velocity of a thrown or hit object during and after the time it is acted on by the force;(DOK 1)
P3.4g Explain how the time of impact can affect the net force.(DOK 1)

P3.5a Apply conservation of momentum to solve simple collision problems;(DOK 1)
P3.6A Explain earth-moon interactions in terms of forces;(DOK 1)
P3.6B Predict how the gravitational force between objects changes when the distance between them changes;(DOK 1)
P3.6C Explain how your weight on Earth could be different from your weight on another planet;(DOK 1)
P3.6d Calculate force, masses, or distance, given any three of these quantities, by applying the Law of Universal Gravitation, given the value of G;(DOK 1)
P4.2e Explain the energy transformation as an object falls at a steady velocity;(DOK 1)
P4.3f Calculate the impact speed of an object dropped from a specific height or the maximum height reached by an object, given the initial vertical velocity.(DOK 1)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. Net force is equal to mass times acceleration. The unbalanced force on an object determines how much an object speeds up or slows down 2. Objects change their state of motion only when a net force is applied 3. How are weight and mass related 4. All objects in the universe attract each other through the force of gravity 5. In the absence of air resistance, all objects falling near Earth's surface accelerate at the same rate regardless of their mass 6. Projectile motion has two components—horizontal and vertical. When the two motions are combined, they form a curved path 7. For movement along a straight line, momentum is calculated by multiplying an object's mass and velocity 8. The total momentum of two or more objects after a collision is the same as it was before the collision. In other words, the total amount of momentum in an isolated system is conserved. **The following vocabulary words:** 9. inertia: the tendency of an object to resist a change in motion unless an outside force acts on the object 10. net force: mass × acceleration, or F = ma 11. mass: a measure of the amount of matter in an object 12. weight: the gravitational force an object experiences because of its mass 13. free fall: the motion of a body when only the	1. Determines how much an object speeds up or slows down 2. Determine what makes an object speed up, slow down, or change directions 3. calculate the weight of an object given the mass and the value of free-fall acceleration 4. Explain why do objects fall to the ground when dropped using the Law of Universal Gravitation 5. Explain is the relationship between free-fall acceleration and mass 6. Explain why a projectile follow a curved path 7. Calculate the momentum of an object 8. Use the Law of Conservation of momentum to determine the total momentum after objects collide

force of gravity is acting on the body 14. projectile motion: the curved path that an object follows when thrown, launched, or otherwise projected near the surface of Earth 15. momentum: a quantity defined as the product of the mass and velocity of an object	

Phase II Curriculum

Unit: Work & Energy

Essential Questions:	**Essential Understanding:**
● What is the difference between kinetic and potential energy? ● How do you calculate kinetic energy? ● What are some different forms of potential energy? ● How do you calculate gravitational potential energy? ● Describe how energy can be transformed from one form to another. ● How is mechanical energy related to kinetic and potential energy? ● Why is mechanical energy not always conserved ● What is the law of conservation of energy? ● How are power and energy related?	● Every change that occurs requires energy ● There are different forms of energy, including potential energy and kinetic energy ● Energy cannot be created or destroyed, but only can change from one form to another ● Distinguish between kinetic and potential energy ● Calculate kinetic energy ● Describe different forms of potential energy ● Describe how energy can be transformed from one form to another ● Explain how the mechanical energy of a system is the sum of the kinetic and potential energy ● Law of Conservation of Energy ● Work is done when a force causes something to move. ● Explain the meaning of work ● Describe how work and energy are related ● Calculate work ● Calculate power.

Curriculum Standards- DOK noted where applicable with Standards

P1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions;(DOK 3)
P1.1C Conduct scientific investigations using appropriate tools and techniques;(DOK 2)
P1.1D Identify patterns in data and relate them to theoretical models;(DOK 2)
P1.1E Describe a reason for a given conclusion using evidence from an investigation;(DOK 3)
P1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation;(DOK 3)
P1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables;(DOK 3)
P1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions;(DOK 2)
P2.1h Identify the changes in speed and direction in everyday examples of circular, periodic, and projectile motions; (DOK 1)
P2.2f Describe the relationship between changes in position, velocity, and acceleration during periodic motion;(DOK 2)
P3.2B Compare work done in different situations;(DOK 2)
P3.2d Calculate all the forces on an object on an inclined plane and describe the object's motion based on the

forces using free-body diagrams;(DOK 2)
P3.p2A Trace energy transfers involving various types of energy including nuclear, chemical, electrical, sound, and light; (DOK P)
P4.1B Explain instances of energy transfer by waves and objects in everyday activities;(DOK 1)
P4.1c Explain why work has a more precise scientific meaning than the meaning of work in everyday language; (DOK 1)
P4.1d Calculate the amount of work done on an object that is moved from one position to another;(DOK 1)
P4.1e Using the formula for work, derive a formula for change in potential energy of an object lifted a distance h; (DOK 1)
P4.2A Account for and represent energy transfer and transformation in complex processes;(DOK 2)
P4.2B Name devices that transform specific types of energy into other types;(DOK 1)
P4.2C Explain how energy is conserved in common systems;(DOK 1)
P4.2D Explain why all the stored energy in gasoline does not transform to mechanical energy of a vehicle; (DOK 1)
P4.2f Identify and label the energy inputs, transformations, and outputs using qualitative or quantitative representations in simple technological systems to show energy conservation;(DOK 1)
P4.3A Identify the form of energy in given situations;(DOK 1)
P4.3B Describe the transformation between potential and kinetic energy in simple mechanical systems;(DOK 1)
P4.3C Explain why all mechanical systems require an external energy source to maintain their motion;(DOK 1)
P4.3d Rank the amount of kinetic energy from highest to lowest of everyday examples of moving objects; (DOK 2)
P4.3e Calculate the changes in kinetic and potential energy in simple mechanical systems using the formulas for kinetic energy and potential energy.(DOK 1)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. Work is calculated by multiplying the force by the distance over which the force is applied. 2. Power is the rate at which work is done, or how much work is done in a given amount of time. 3. Machines help do work by changing the size of an input force, the direction of the force, or both. 4. The six types of simple machines are the simple lever, the pulley, the wheel and axle, the simple inclined plane, the wedge, and the screw. 5. All levers have a rigid arm that turns around a point called the fulcrum. 6. Pushing an object up an inclined plane requires less input force than lifting the same object does. 7. A pair of scissors uses two first-class levers joined at a common fulcrum; each lever arm has a wedge that cuts into the paper. 8. Whenever work is done, energy is	1. Calculate work give the force and the distance 2. Explain relationship between work and power 3. Describe several ways that machines make work easier 4. List the six types of simple machines 5. Label the two principal parts of a lever and the effort and resistance points 6. Explain how using an inclined plane change the force required to do work 7. Determine what simple machines make up a pair of scissors (or another compound machine) 8. Explain the relationship between energy and work 9. Calculate the potential energy called energy of an object 10. Calculate the kinetic energy of a moving object 11. Explain the difference between nonmechanical and mechanical energy 12. List and describe energy changes in a system 13. Explain the law of conservation of energy

transformed or is transferred from one system to another system.

9. Potential energy (PE) is sometimes called energy of position because it results from the relative positions of objects in a system.
10. Kinetic energy depends on both the mass and the speed of an object.
11. Energy that lies at the level of the atom is sometimes called nonmechanical energy.
12. Energy readily changes from one form to another.
13. Energy cannot be created or destroyed. In other words, the total amount of energy in the universe never changes, although energy may change from one form to another.
14. Only a portion of the work done by any machine is useful work— that is, work that the machine is designed or intended to do.

The following vocabulary words:

15. work: the transfer of energy to an object by the application of a force that causes the object to move in the direction of the force
16. power: a quantity that measures the rate at which work is done or energy is transformed
17. potential energy: the energy that an object has because of the position, shape, or condition of the object
18. kinetic energy: the energy of an object due to the object's motion
19. mechanical energy: the amount of work an object can do because of the object's kinetic and potential energies
20. efficiency: a quantity, usually expressed as a percentage, that measures the ratio of useful work output to work input

14. Calculate how much of the work done by a machine is actually useful work

Phase II Curriculum

Unit: Heat & Temperature

Essential Questions:	**Essential Understanding:**
● What is temperature? ● How are thermal energy and temperature related? ● What is the difference between thermal energy and heat? ● How do you calculated changed in thermal energy? ● What are conduction, convection, and radiation? ● How do thermal conductors differ from thermal insulators? ● How are thermal insulators used to control the transfer of thermal energy? ● What are some common types of heating systems? ● What are the first and second laws of thermodynamics?	● Thermal energy flows from an area of higher temperature to an area of lower temperature ● Atoms and molecules that make up matter are in continual random motion ● Explain how thermal energy depends on temperature ● Explain how thermal energy and energy are related ● There are three ways thermal energy is transferred: conduction, convection, radiation ● Thermal energy can be made useful by controlling its production and movement ● Describe common types of heating systems

Curriculum Standards- DOK noted where applicable with Standards

C2.2A Describe conduction in terms of molecules bumping into each other to transfer energy. Explain why there is better conduction in solids and liquids than gases;(DOK 2)
C2.2d Explain convection and the difference in transfer of thermal energy for solids, liquids, and gases using evidence that molecules are in constant motion;(DOK 2)
C2.2e Compare the entropy of solids, liquids, and gases;(DOK 2)
C5.4A Compare the energy required to raise the temperature of one gram of aluminum and one gram of water the same number of degrees;(DOK 2)
E2.1B Analyze the interactions between the major systems that make up the Earth; (DOK 2)
E2.2A Describe the Earth's principal sources of internal and external energy; (DOK 1)
E2.2C Describe natural processes in which heat transfer in the Earth occurs by conduction, convection, and radiation; (DOK 1)
E2.2e Explain how energy changes form through Earth systems; (DOK 2)
E4.p2A Describe the major causes for the ocean's surface and deep water currents, including the prevailing winds, the Coriolis effect, unequal heating of the earth, changes in water temperature and salinity in high latitudes, and basin shape; (DOK P)
P1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions;(DOK 3)
P1.1C Conduct scientific investigations using appropriate tools and techniques;(DOK 2)
P1.1D Identify patterns in data and relate them to theoretical models;(DOK 2)
P1.1E Describe a reason for a given conclusion using evidence from an investigation;(DOK 3)

P1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation;(DOK 3)
P1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables;(DOK 3)
P1.2D Evaluate scientific explanations in a peer review process or discussion format;(DOK 3)
P3.p1A Explain that the amount of energy necessary to heat a substance will be the same as the amount of energy released when the substance is cooled to the original temperature;
P4.1B Explain instances of energy transfer by waves and objects in everyday activities;(DOK 1)
P4.2B Name devices that transform specific types of energy into other types;(DOK 1)
P4.2C Explain how energy is conserved in common systems;(DOK 1)
P4.11b Calculate the final temperature of two liquids at the same or different temperatures and masses that are combined.(DOK 1)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. The temperature of a substance is proportional to the average kinetic energy of the substance's particles. 2. The Fahrenheit, Celsius, and Kelvin temperature scales are commonly used for different applications in different parts of the world. 3. The feeling associated with temperature difference results from energy transfer. 4. Heat energy can be transferred in three ways: conduction, convection, and radiation. 5. A conductor is a material through which energy can be easily transferred as heat. An insulator is a material that transfers energy poorly. 6. What makes a substance a good or poor conductor depends in part on how much energy is required to change the temperature of the substance by a certain amount. 7. The first law of thermodynamics states that the total energy used in any process is conserved, whether that energy is transferred as a result of work, heat, or both. The second law of thermodynamics states that the energy transferred as heat always moves from an object at a higher temperature to an object at a lower temperature. 8. In a heat engine, potential chemical energy and internal kinetic energy are converted to mechanical energy by the process of combustion **The following vocabulary words:**	1. Describe the relationship between temperature and molecular kinetic energy 2. Determine which of the three temperature scales should be used in the specific situation 3. Explain what makes things feel hot or cold 4. Describe energy transfers in common systems 5. Compare and contrast conductors and insulators 6. Describe what makes something a good conductor of heat 7. Determine what happens to heat energy when it is transferred from one object to another 8. Explain how heat engines work

9. temperature: a measure of how hot (or cold) something is; specifically, a measure of the average kinetic energy of the particles in an object 10. absolute zero: the temperature at which molecular energy is at a minimum 11. heat: the energy transferred between objects that are at different temperatures 12. convection: the movement of matter due to differences in density that are caused by temperature variations 13. heat engine: a machine that transforms heat into mechanical energy, or work	

Phase II Curriculum

Unit: Waves

Essential Questions:	**Essential Understanding:**
● How do waves transfer energy? ● What are mechanical waves? ● How do transverse waves differ from longitudinal waves? ● How are wavelength and period related? ● What is the relationship between frequency and wavelength? ● How do you calculate the speed of a wave? ● What is the law of reflection? ● Why do waves change direction when they travel from one material to another? ● How are refraction and diffraction similar and different? ● What happens when waves interfere with each other?	● Waves move through matter as energy is transferred from particle to particle. ● Wave properties depend on the vibrations of the wave source and the material in which the wave moves. ● Waves can change direction when they interact with matter. ● Waves transfer energy from place to place without transferring matter.

Curriculum Standards- DOK noted where applicable with Standards

C2.4d Compare various wavelengths of light in terms of frequency and relative energy;(DOK 2)
P1.1C Conduct scientific investigations using appropriate tools and techniques;(DOK 2)
P1.1E Describe a reason for a given conclusion using evidence from an investigation;(DOK 3)
P1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation;(DOK 3)
P1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables;(DOK 3)
P1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions;(DOK 2)
P1.2j Apply science principles or scientific data to anticipate effects of technological design decisions;(DOK 2)
P4.4B Identify everyday examples of transverse and compressional waves;(DOK 1)
P4.5A Identify everyday examples of energy transfer by waves and their sources;(DOK 1)
P4.5B Explain why an object does not move forward as a wave passes under it;(DOK 1)
P4.5D Explain how waves propagate from vibrating sources and why the intensity decreases with the square of the distance from a point source;(DOK 2)
P4.6B Explain why radio waves can travel through space, but sound waves cannot;(DOK 1)
P4.6C Explain why there is a delay between the time we send a radio message to astronauts on the moon and when they receive it;(DOK 1)
P4.6f Explain how radio waves are modified to send information in radio and television programs, radio-control cars, cell phone conversations, and GPS systems.(DOK 1)
P4.4B Identify everyday examples of transverse and compression waves;(DOK 1)
P4.4C Compare and contrast transverse and compression waves in terms of wavelength, amplitude, and frequency; (DOK 2)
P4.4d Demonstrate that frequency and wavelength of a wave are inversely proportional in a given medium;

(DOK 1)
P4.4e Calculate the amount of energy transferred by transverse or compression waves of different amplitudes and frequencies;(DOK 1)
P4.5A Identify everyday examples of energy transfer by waves and their sources;(DOK 1)
P4.5B Explain why an object does not move forward as a wave passes under it;(DOK 1)
P4.6A Identify the different regions on the electromagnetic spectrum and compare them in terms of wavelength, frequency, and energy;(DOK 2)
P4.6D Explain why we see a distant event before we hear it;(DOK 1)
P4.6g Explain how different electromagnetic signals can take place without interfering with each other;(DOK 1)
P4.6h Explain the relationship between the frequency of an electromagnetic wave and its technological uses; (DOK 1)
P4.r7a Calculate and compare the energy in various electromagnetic quanta.(DOK R)
P4.8c Describe how two wave pulses propagated from opposite ends of a demonstration spring interact as they meet; (DOK 1)
P4.8d List and analyze everyday examples that demonstrate the interference characteristics of waves.(DOK 1)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. A wave is a disturbance that carries energy through matter or space. 2. Most waves are caused by vibrating objects. 3. A transverse wave is a wave in which the wave motion is perpendicular to the particle motion. A longitudinal wave is a wave in which the wave motion is parallel to the particle motion. 4. The particles in a surface wave move both perpendicularly and parallel to the direction in which the wave travels. 5. Amplitude and wavelength are measurements of distance. Period and frequency are measurements based on time. 6. The speed of a wave is equal to wavelength divided by period, or to frequency multiplied by wavelength 7. .Motion between the source of waves and the observer creates a change in observed frequency 8. When a wave meets a surface or a boundary, the wave bounces back. When a wave passes the edge of an object or passes through an opening, the wave bends. A wave also bends when it passes from one medium to another at an angle. 9. When several waves are in the same location, they combine to produce a single, new wave that is different from the original	1. Explain how a wave can carry energy through a medium 2. Describe ways waves can be generated 3. Explain the difference between a transverse wave a longitudinal wave 4. Describe how the particles in ocean waves move 5. List the ways to measure and compare waves 6. Calculate the speed of a wave using wavelength and frequency (or period) 7. Describe why the pitch of an ambulance siren change as the ambulance rushes past you 8. Determine how waves will behave when they hit a boundary, when they pass around an edge or opening, and when they pass from one medium to another 9. Describe what happens when two waves are in the same location 10. Show are standing waves formed

waves. This interaction is called interference. 10. A standing wave causes the medium to vibrate in a stationary pattern that resembles a loop or a series of loops. **The following vocabulary words:** 11. medium: a physical environment in which phenomena occur 12. mechanical wave: a wave that requires a medium through which to travel 13. electromagnetic wave: a wave that consists of oscillating electric and magnetic fields, which radiate outward at the speed of light 14. transverse wave: a wave in which the particles of the medium move perpendicularly to the direction the wave is traveling 15. longitudinal wave: a wave in which the particles of the medium vibrate parallel to the direction of wave motion 16. surface waves: waves that occur at the boundary between two different mediums, such as water and air 17. amplitude: the maximum distance that the particles of a wave's medium vibrate from their rest position 18. period: a measurement of the time it takes for a wave to pass a given point. 19. Frequency:a measurement of the vibration rate. 20. Doppler effect: an observed change in the frequency of a wave when the source or observer is moving	

Phase II Curriculum

Unit: Sound & Light

Essential Questions:

- How does sound travel through different mediums?
- What affects the speed of sound?
- How does your ear enable you to hear?
- How are amplitude, intensity, and loudness related?
- How is sound intensity measured?
- What is the relationship between frequency and pitch?
- What is the Doppler Effect?
- What is the difference between noise and music?
- How do string, wind, and percussion instruments produce music?
- What are beats, and why do they occur?
- What are some of the factors that affect the design of concert halls and movie theaters?
- How does a vibrating electric charge produce an electromagnetic wave?
- What properties describe electromagnetic waves?
- How do electromagnetic waves transfer energy?
- What are the main divisions of the electromagnetic spectrum?
- What are the properties of each type of electromagnetic wave?
- What are some common uses of each type of electromagnetic wave?
- What technologies use radio and microwaves for communication?
- How are transparent, translucent and opaque materials different?
- What is the difference between regular and diffuse reflection?
- What is the index of refraction of a material?
- Why does a prism separate white light into different colors?
- How do you see color?
- How do different types of mirrors form images?
- What are real images and virtual images?
- What are some examples of plane, convex,

Essential Understanding:

- Sound waves are compressional wave that can only travel through matter
- The loudness of a sound depends on its intensity and its pitch depends on its frequency
- Musical instruments produce a combination of frequencies that determine how the instrument sounds
- Sound waves are used to locate objects from images, and to treat medical problems
- Sound waves are compressional waves produced by something that vibrates.
- Electromagnetic waves can transfer energy through matter and space
- Electromagnetic waves are transverse waves that can be produced by vibrating electric charges
- Each type of electromagnetic wave has a certain range of frequencies and wavelengths
- Signals and information can be transmitted using radio waves.
- All objects/materials radiate electromagnetic waves
- Visible light are electromagnetic waves that can be detected by the human eye.
- Light waves change direction when they are reflected or change speed
- Light waves of different wavelengths or combinations of wavelengths cause the human eye to detect different colors
- Mirrors and lenses form images by causing light rays to change direction
- Light rays can change direction when they are reflected by a mirror
- Light rays are bent when they pass through a lens

concave mirrors? ● In what ways do convex lenses and concave lenses bend light rays? ● What types of images do convex lenses and concave lenses form?	

Curriculum Standards- DOK noted where applicable with Standards

C2.4d Compare various wavelengths of light in terms of frequency and relative energy;(DOK 2)
P1.1C Conduct scientific investigations using appropriate tools and techniques;(DOK 2)
P1.1D Identify patterns in data and relate them to theoretical models;(DOK 3)
P1.1E Describe a reason for a given conclusion using evidence from an investigation;(DOK 3)
P1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation;(DOK 3)
P1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables;(DOK 3)
P1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information;(DOK 3)
P4.1B Explain instances of energy transfer by waves and objects in everyday activities;(DOK 1)
P4.2B Name devices that transform specific types of energy into other types(DOK 1)
P4.5C Provide evidence to support the claim that sound is energy transferred by a wave, not energy transferred by particles;(DOK 2)
P4.5E Explain why everyone in a classroom can hear one person speaking, but why an amplification system is often used in the rear of a large concert auditorium.(DOK 1)
P4.6A Identify the different regions on the electromagnetic spectrum and compare them in terms of wavelength, frequency, and energy;(DOK 2)
P4.6B Explain why radio waves can travel through space, but sound waves cannot;
P4.6C Explain why there is a delay between the time we send a radio message to astronauts on the moon and when they receive it;(DOK 1)
P4.6e Explain why antennas are needed for radio, television, and cell phone transmission and reception;(DOK 1)
P4.6f Explain how radio waves are modified to send information in radio and television programs, radio-control cars, cell phone conversations, and GPS systems;(DOK 1)
P4.6g Explain how different electromagnetic signals can take place without interfering with each other;(DOK 1)
P4.6h Explain the relationship between the frequency of an electromagnetic wave and its technological uses; (DOK 1)
P4.r7a Calculate and compare the energy in various electromagnetic quanta;(DOK R)
P4.r9d Describe evidence that supports the dual wave - particle nature of light.(DOK R)
P4.8A Draw ray diagrams to indicate how light reflects off objects or refracts into transparent media;(DOK 1)
P4.8B Predict the path of reflected light from flat, curved, or rough surfaces;(DOK 1)
P4.8e Given an angle of incidence and indices of refraction of two materials, calculate the path of a light ray incident on the boundary; P4.8f Explain how Snell's Law is used to design lenses;(DOK 1)
P4.9A Identify the principle involved when you see a transparent object in a clear liquid;(DOK 1)
P4.9B Explain how various materials reflect, absorb, or transmit light in different ways;(DOK 1)
P4.9C Explain why the image of the Sun appears reddish at sunrise and sunset; (DOK 1)

LEARNING TARGETS

Knowledge/Content I Know …	Skills/Processes I Can …
1. Sound waves are caused by vibrations and carry energy through a medium. 2. Most instruments produce sound through the vibration of strings, air columns, or membranes. 3. The human ear is a sensitive organ that senses vibrations in the air, amplifies them, and then transmits signals to the brain. 4. Reflected sound waves are used to determine distances and to create images 5. The two most common models describe light either as a wave or as a stream of particles 6. .The electromagnetic spectrum consists of light at all possible energies, frequencies, and wavelengths. 7. Every object reflects some light and absorbs some light. 8. Mirrors reflect light as described by the law of reflection, and this light reaches your eyes. The type of image you perceive depends on the type of mirror 9. The colors that you perceive depend on the wavelengths of visible light that reach your eyes. 10. Light waves bend, or refract, when they pass from transparent one medium to another 11. .When light passes through a medium that has a curved surface, a lens, the light rays change direction. 12. A prism can separate the colors of light because the speeds of light waves traveling through the medium depend on the wavelengths of light **The following vocabulary words:**. 13. <u>sound wave</u>: a longitudinal wave that is caused by vibrations and that travels through a material medium 14. <u>loudness</u>: depends partly on the energy contained in the sound wave 15. <u>intensity</u>: describes the rate at which a sound wave transmits energy through a given area	1. Explain the characteristics of sound waves 2. Describe the various ways musical instruments make sound 3. Explain how ears function to allow humans hear sound waves 4. Explain multiple ways the reflections of sound waves used in modern technology 5. Explain the two scientific models of light 6. List the components of the electromagnetic spectrum 7. Show how objects interact with incoming light rays 8. Draw and explain how an image in a mirror is forms 9. Explain how the eye sees colors 10. Explain what happens to light when it passes from one medium to another medium 11. Show what happens when light passes through a lens 12. Explain how can a prism separate white light into colors

of a medium

16. pitch: a measure of how high or low a sound is perceived to be depending on the frequency of the sound wave
17. infrasound: slow vibrations of frequencies lower than 20 Hz
18. ultrasound: is any sound wave with frequencies higher than 20,000 Hz
19. resonance: a phenomenon that occurs when two objects naturally vibrate at the same frequency
20. natural frequencies: the specific frequencies at which an object is most likely to vibrate
21. Sonar: sound navigation and ranging, a system that uses acoustic signals and echo returns to determine the location of objects or to communicate.
22. photon: a unit or quantum of light
23. dual nature of light: light can behave both as waves and as particles
24. Radar: radio detection and ranging, a system that uses reflected radio waves to determine the velocity and location of objects
25. diffuse reflection: the reflection of light in random directions
26. law of reflection: When light hits a smooth surface, the angle of incidence (θ) equals the angle of reflection (θ').
27. angle of reflection: the angle of the light rays reflecting off a surface
28. angle of incidence: the angle of the light rays striking the surface
29. virtual image: an image that forms at a location from which light rays appear to come but do not actually come
30. real image: an image of an object formed by light rays that actually come together at a specific location
31. mirage: a virtual image caused by light in the atmosphere
32. dispersion: the process of separating a wave (such as white light) of different frequencies into its individual component waves (the different colors)

Phase II Curriculum

Unit: Electricity

Essential Questions:	**Essential Understanding:**
● How can an object become electrically charged? ● When and how does a voltage difference produce an electric current? ● How do batteries produce a voltage difference in a circuit? ● How can you calculate electric power? ● How do series circuits differ from parallel circuits?	● Like electrical charges attract each other and unlike charges repel ● Electrical energy can be converted into other forms of energy in a circuit ● A voltage difference causes electrons to flow in a circuit. ● The flow of electric charges in a circuit is a source of electrical energy.

Curriculum Standards- DOK noted where applicable with Standards

P3.7A Predict how the electric force between charged objects varies when the distance between them and/or the magnitude of charges change.(DOK 1)
P3.7B Explain why acquiring a large excess static charge (e.g., pulling off a wool cap, touching a Van de Graaff generator, combing) affects your hair..(DOK 1)
P3.7c Draw the redistribution of electric charges on a neutral object when a charged object is brought near. (DOK 1)
P3.7d Identify examples of induced static charges.(DOK 1)
P3.7e Explain why an attractive force results from bringing a charged object near a neutral object.(DOK 1)
P3.7f Determine the new electric force on charged objects after they touch and are then separated.(DOK 1)
P3.7g Propose a mechanism based on electric forces to explain current flow in an electric circuit.(DOK 1)
4.10g Compare the currents, voltages, and power in parallel and series circuits;(DOK 2)
P4.10h Explain how circuit breakers and fuses protect household appliances;(DOK 1)
P4.10i Compare the energy used in one day by common household appliances;(DOK 2)
P4.10j Explain the difference between electric power and electric energy as used in bills from an electric company.(DOK 2)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. An object can have a negative charge, a positive charge, or no charge at all.	1. Define the different kinds of electric charge 2. Explain how materials become charged when

2. When different materials are rubbed together, electrons can be transferred from one material to the other.
3. The electric force at the atomic and molecular levels is responsible for most of the everyday forces that we observe, such as the force of a spring and the force of friction.
4. Just as a ball will roll downhill, a negative charge will move away from another negative charge.
5. Resistance is caused by internal friction, which slows the movement of charges through a conducting material.
6. The conducting path produced when a load, such as a string of light bulbs, is connected across a source of voltage is called a closed circuit.
7. Electrical devices can be connected as a series circuit so that the voltage is divided among the devices. They can also be connected as a parallel circuit so that the voltage is the same across each device.
8. Some of this energy is transformed into useful work, such as the turning of a motor, and some is lost as heat.
9. The high currents in overloaded circuits can cause fires.

The following vocabulary words:

10. electric charge: an electrical property of matter that creates electric and magnetic forces and interactions.
11. electrical conductor: a material in which charges can move freely
12. electrical insulator: a material in which charges cannot move freely
13. electric force: the force of attraction or repulsion on a charged particle that is due to an electric field
14. electric field: the force of attraction or repulsion on a charged particle that is due to an electric field
15. electrical potential energy (voltage): the ability to move an electric charge from one point to another
16. Conventional current: the current made of positive charge that would have the same effect as the actual motion of charge in the material.
17. resistance: the opposition presented to the current by a material or device
18. semiconductors: materials that have electrical properties between those of insulators and conductors

rubbed together
3. Determine what force is responsible for most everyday forces
4. Describe how electrical potential energy and gravitational potential energy are similar
5. Explain what causes electrical resistance
6. Show the difference between closed circuits and open circuits
7. Demonstrate the two ways that devices can be connected in a circuit
8. Explain what happens to the energy that charges have in a circuit
9. Explain why an overloaded circuit is dangerous

19. electric circuit: a set of electrical components connected such that they provide one or more complete paths for the movement of charges 20. schematic diagram: a graphical representation of a circuit that uses lines to represent wires and different symbols to represent components 21. series circuit: a circuit in which the parts are joined one after another such that the current in each part is the same 22. parallel circuit: a circuit in which the parts are joined in branches such that the potential difference across each part is the same 23. electrical power: the rate at which electrical energy is converted into other forms of energy 24. fuse: an electrical device that contains a metal strip that melts when current in the circuit becomes too great 25. circuit breaker: a switch that opens a circuit automatically when the current exceeds a certain value.	

Phase II Curriculum

Unit: Magnetism

Essential Questions:.	**Essential Understanding:**
● What do electricity and magnetism have in common? ● What are the properties of magnets? ● What does the magnetic force of the Earth do? ● Can electricity produce magnetic effects?	● Magnets are accompanied by magnetic fields that can exert forces on other magnets and transfer energy from one to the other ● Magnetic materials can pull or push other magnetic materials even without touching them ● Electricity and magnetism are both forces ● Magnetic field lines always form closed loops that run from the magnetic north pole to the south pole ● Electric current produces a magnetic field ● Electric current can be created with magnetism using a generator ● Electric voltage and current can be stepped up or down using a transformer

Curriculum Standards- DOK noted where applicable with Standards

P1.1C Conduct scientific investigations using appropriate tools and techniques;(DOK 2)
P1.1D Identify patterns in data and relate them to theoretical models;(DOK 2)
P1.1E Describe a reason for a given conclusion using evidence from an investigation;(DOK 3)
P1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation;(DOK 3)
P1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables;(DOK 3)
P1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information;(DOK 3)
P1.2D Evaluate scientific explanations in a peer review process or discussion format; (DOK 3)
P1.2k Analyze how science and society interact from a historical, political, economic, or social perspective; (DOK 2)
P3.p8A Create a representation of magnetic field lines around a bar magnet and qualitatively describe how the relative strength and direction of the magnetic force changes at various places in the field.(DOK P)
P3.8b Explain how the interaction of electric and magnetic forces is the basis for electric motors, generators, and the production of electromagnetic waves.(DOK 1)

LEARNING TARGETS

Knowledge/Content I Know …	Skills/Processes I Can …
1. Two like poles repel each other. Two unlike poles attract each other. 2. Magnets repel or attract each other because of the interaction of their magnetic fields. 3. Earth's magnetic field lines run from geographic south to geographic north. 4. When the wire carries a strong, steady current, all of the compass needles move to align with the magnetic field created by the electric current. 5. A motor can perform mechanical work when it is attached to an external device. 6. Moving a magnet into and out of a coil of wire causes charges in the wire to move 7. .Electricity and magnetism are two aspects of a single force, the electromagnetic force. 8. In its simplest form, a transformer consists of two coils of wire wrapped around opposite sides of a closed iron loop. **The following vocabulary words:** 9. magnetic pole: one of two points, such as the ends of a magnet, that have opposing magnetic qualities 10. magnetic field: a region where a magnetic force can be detected 11. magnetic domains: groups of atoms that all line up the same way and form small, magnetized regions within a material 12. right-hand rule: If you hold a wire in your right hand and point your thumb in the direction of the positive current, the direction that your fingers curl is the direction of the magnetic field. 13. solenoid: a coil of wire with an electric current in it 14. electromagnet: a coil that has a soft iron core and that acts as a magnet when an electric current is in the coil 15. galvanometer: an instrument that detects, measures, and determines the direction of a small electric current 16. ammeter: measures current 17. voltmeter: measures voltage	1. What happens when the poles of two magnets are brought close together 2. What causes a magnet to attract or repel another magnet 3. How is Earth's magnetic field oriented 4. What happens to a compass near a wire that is carrying a current 5. Why are electric motors useful 6. What happens when a magnet is moved into or out of a coil of wire 7. How are electricity and magnetism related 8. What are the basic components of a transformer

18. commutator: a device used to make the current change direction every time the flat coil makes a half revolution 19. electromagnetic induction: the process of creating a current in a circuit by changing a magnetic field 20. generator: a machine that converts mechanical energy to electrical energy 21. alternating current (AC): an electric current that changes direction at regular intervals 22. transformer: a device that increases or decreases the voltage of alternating current	

Phase II Curriculum

Unit: Matter

Essential Questions:	**Essential Understanding:**
● What are substances and mixtures? ● Identify elements and compounds. ● Compare and contrast solutions, colloids, and suspensions. ● Can you identify substances using physical properties? ● What is the difference between physical and chemical changes? ● Identify chemical changes. ● How does the law of conservation of mass apply to chemical changes?	● Matter can be either a pure substance (an element or compound) or a mixture (either homogeneous or heterogeneous). ● A physical property can be observed without changing the identity of the substance. ● A chemical property describes whether it can undergo a chemical change. ● Matter can be classified by what it is made of, by its physical properties, and by its chemical properties

Curriculum Standards- DOK noted where applicable with Standards

C1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions(DOK 3)
C1.1C Conduct scientific investigations using appropriate tools and techniques(DOK 2)
C1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables(DOK 3)
C3.3B Describe melting on a molecular level(DOK 1)
C4.2A Name simple binary compounds using their formulae(DOK 1)
C4.2c Given a formula, name the compound(DOK 1)
P4.p2A Distinguish between an element, compound, or mixture based on drawings or formulae (DOK P)
P4.p2B Identify a pure substance based on unique chemical and physical properties.(DOK P)
P4.p2C Separate mixtures based on the differences in physical properties of the individual components (DOK P)
P4.p2D Recognize that the properties of a compound differ from those of its individual elements.(DOK P)
C4.4a Explain why at room temperature different compounds can exist in different phase2)
C5.4c Explain why both the melting point and boiling points for water are significantly higher than other small molecules of comparable mass (DOK 2)
C5.2B Distinguish between chemical and physical changes in terms of the properties of the reactants and products (DOK 2)
C5.2C Draw pictures to distinguish the relationships between atoms in physical and chemical changes(DOK 2)

LEARNING TARGETS

Knowledge/Content	**Skills/Processes**

I Know …	I Can …
1. Every sample of matter is either an element, a compound, or a mixture. 2. Each element is made of one kind of atom. 3. Each molecule of a compound contains two or more elements that are chemically combined. Elements combine chemically to form a compound. 4. Elements and compounds are pure substances, but mixtures are not. 5. Physical properties are characteristics that can be observed without changing the identity of the substance. 6. A chemical property describes how a substance changes into a new substance, either by combining with other elements or by breaking apart into new substances 7. .A physical change affects one or more properties of a substance without changing the identity of the substance. 8. A chemical change happens when one or more substances are changed into entirely new substances that have different properties. 9. Mixtures can be separated by physical changes, but compounds must be broken down by chemical changes. **The following vocabulary words:** 10. element: a substance that cannot be separated or broken down into simpler substances by chemical means 11. atom: the smallest unit of an element that maintains the properties of that element 12. molecule: the smallest particle of a substance that has all of the chemical properties of that substance; a molecule is made up of one atom or two or more atoms bonded together 13. compound: a substance made up of atoms of two or more different elements joined by chemical bonds 14. pure substance: a sample of matter, either a single element or a single compound, that has definite chemical and physical properties 15. mixture: a combination of two or more substances that are not chemically combined 16. heterogeneous mixture: substances aren't mixed uniformly and are not evenly distributed 17. homogeneous mixture: substances are evenly distributed, and the mixture is the same throughout 18. miscible: substances that can be mixed	1. Classify matter as an element, a compound, or a mixture. 2. Explain why carbon and copper classified as elements but water and salt are not 3. Explain how elements are related to compounds 4. Define the differences between a pure substance and a mixture 5. Determine which properties are physical 6. Determine which properties are chemical 7. Explain why getting a haircut is an example of a physical change 8. Explain why baking bread is an example of a chemical change 9. Show how mixtures and compounds can be broken down

19. immiscible: substances that cannot be mixed 20. melting point: the temperature and pressure at which a solid becomes a liquid 21. boiling point: the temperature and pressure at which a liquid becomes a gas 22. density: the ratio of the mass of a substance to the volume of the substance 23. flammability: the ability to burn 24. reactivity: the capacity of a substance to combine chemically with another substance 25. physical change: a change of matter from one form to another without a change in chemical properties 26. chemical change: a change that occurs when one or more substances change into entirely new substances with different properties	

Phase II Curriculum

Unit: States of Matter

Essential Questions:	**Essential Understanding:**
● What is the kinetic theory of matter? ● Describe particle movement in the four states of matter. ● What happens to particle behavior at the melting and boiling points?	● Solids, liquids, and gases differ by the amount of thermal energy their particles have. ● Many physical properties of matter can be described by the motion of its particles ● Phase changes define the change of state from one matter to another.

Curriculum Standards- DOK noted where applicable with Standards

P4.p1A For a substance that can exist in all three phases, describe the relative motion of the particles in each of the phases. (DOK P)
P4.p1B For a substance that can exist in all three phases, make a drawing that shows the arrangement and relative spacing of the particles in each of the phases (DOK P)
P4.p1C For a simple compound, present a drawing that shows the number of particles in the system does not change as a result of a phase change. (DOK P)
P4.2C Explain how energy is conserved in common systems (DOK 1)
P4.2f Identify and label the energy inputs, transformations, and outputs using qualitative or quantitative representations in simple technological systems to show energy conservation (DOK 1)
C1.1C Conduct scientific investigations using appropriate tools and techniques (DOK 2)
C1.1D Identify patterns in data and relate them to theoretical models (DOK 2)
C1.1E Describe a reason for a given conclusion using evidence from an investigation (DOK 3)
C1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation (DOK 3)
C1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables (DOK 3)
C1.2B Identify and critique arguments about personal or societal issues based on scientific evidence (DOK 3)
C1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information (DOK 3)
C1.2j Apply science principles or scientific data to anticipate effects of technological design decisions.(DOK 3)
C2.2B Describe the various states of matter in terms of the motion and arrangement of the molecules making up the substance (DOK 1)

C2.2c Explain changes in pressure, volume, and temperature for gases using the kinetic molecular model (DOK 1)
C2.2e Compare the entropy of solids, liquids, and gases (DOK 2)
C3.3B Describe melting on a molecular level (DOK 1)
C4.3B Recognize that solids have a more ordered, regular arrangement of their particles than liquids and that liquids are more ordered than gases (DOK 1)
C4.5a Provide macroscopic examples, atomic and molecular explanations, and mathematical representations

for the pressure-volume relationship in gases(DOK 2)
C4.5b Provide macroscopic examples, atomic and molecular explanations, and mathematical representations for the pressure-temperature relationship in gases (DOK 2)
C4.5c Provide macroscopic examples, atomic and molecular explanations, and mathematical representations for the temperature-volume relationship in gases (DOK 2)
C5.2A Balance simple chemical equations applying the conservation of matter (DOK 2)
C5.4B Measure, plot, and interpret the graph of the temperature versus time of an ice-water mixture, under slow heating, through melting and boiling (DOK 2)
C5.4d Explain why freezing is an exothermic change of state (DOK 2)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. According to the kinetic theory of matter, all matter is made of atoms and molecules. These atoms and molecules act like tiny particles that are always in motion. 2. You can classify matter as a solid, a liquid, or a gas by determining whether the shape and volume are definite or variable. 3. Because they are in motion, all particles of matter have kinetic energy. 4. The identity of a substance does not change during a change of state, but the energy of a substance does change. 5. Mass and energy are both conserved. Neither mass nor energy can be created or destroyed. 6. Fluids exert pressure evenly in all directions. 7. All fluids exert an upward buoyant force on matter. 8. Pascal's principle states that a change in pressure at any point in an enclosed fluid will be transmitted equally to all parts of the fluid. In other words, if the pressure in a container is increased at any point, the pressure increases at all points by the same amount 9. Fluids move faster through small areas than through larger areas, if the overall flow rate remains constant. Fluids also vary in the rate at which they flow. **The following vocabulary words:** 10. <u>fluid:</u> a nonsolid state of matter in which the atoms or molecules are free to move past each other, as in a gas or liquid 11. <u>plasma</u>: a state of matter that consists of free-moving ions and electrons 12. <u>temperature</u>: a measure of how hot (or cold)	1. Define what makes up matter 2. Explain and diagram the difference between a solid, a liquid, and a gas 3. Determine what kind of energy all particles of matter have 4. Explain what happens when a substance changes from one state of matter to another 5. Determine what happens to mass and energy during physical and chemical changes? 6. Show how fluids exert pressure 7. Diagram the forces on floating and submerged objects 8. Explain what happens when pressure in a fluid changes 9. Determine how condition changes affect the speed of a fluid in motion

something is; specifically, a measure of the average kinetic energy of the particles in an object 13. thermal energy: the total kinetic energy of a substance's atoms 14. evaporation: the change of state from a liquid to a gas 15. sublimation: the process in which a solid changes directly into a gas 16. condensation: the change of state from a gas to a liquid 17. law of conservation of mass: In chemical changes, as well as in physical changes, the total mass of the substances undergoing the change stays the same before and after the change. 18. law of conservation of energy: Energy may be changed to another form during a physical or chemical change, but the total amount of energy present before and after the change is the same. 19. pressure: the amount of force exerted per unit area of a surface 20. pascal: the SI unit of pressure; equal to the force of 1 N exerted over an area of 1 m2 (symbol, Pa) 21. buoyant force: the upward force that keeps an object immersed in or floating on a fluid 22. viscosity: the resistance of a gas or liquid to flow 23. Bernoulli's principle:Fluid pressure decreases as speed increases.	

Phase II Curriculum

Unit: Atoms

Essential Questions:	**Essential Understanding:**
● What are the names and symbols of some common elements? ● What are quarks? ● Describe the electron cloud model of the atom. ● How are electrons arranged in an atom? ● How do you determine the atomic mass and mass number of an atom? ● What are the components of isotopes? ● How do you calculate the average atomic mass of an element?	● Protons and neutrons are located in an atom's nucleus, and electrons are located in an electron cloud surrounding the nucleus ● All atoms of the same element have the same number of protons but can have different numbers of neutrons ● The properties of an element are determined by the composition of its atoms.

Curriculum Standards- DOK noted where applicable with Standards

C1.1C Conduct scientific investigations using appropriate tools and techniques (DOK 2)
C1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables (DOK 3)
C1.1i Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate (DOK 2)
C1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information (DOK 3)
C1.2D Evaluate scientific explanations in a peer review process or discussion format (DOK 3)
C1.2i Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge (DOK 2)
C1.2j Apply science principles or scientific data to anticipate effects of technological design decisions (DOK 2)
C1.2k Analyze how science and society interact from a historical, political, economic, or social perspective (DOK 2)
C2.4a Describe energy changes in flame tests of common elements in terms of the electron transitions (DOK 1)
C2.4b Contrast the mechanism of energy changes and the appearance of absorption and emission spectra (DOK 2)
C2.4c Explain why an atom can absorb only certain wavelengths of light (DOK 1)
C4.6a Calculate the number of moles of any compound or element given the mass of the substance (DOK 1)
C4.6b Calculate the number of particles of any compound or element given the mass of the substance (DOK 1)
C4.8A Identify the location, relative mass, and charge for electrons, protons, and neutrons (DOK 1)
C4.8B Describe the atom as mostly empty space with an extremely small, dense nucleus consisting of the protons and neutrons and an electron cloud surrounding the nucleus (DOK 1)
C4.8h Describe the shape and orientation of s and p orbitals (DOK 1)
C4.8i Describe the fact that the electron location cannot be exactly determined at any given time (DOK 1)
C4.10A List the number of protons, neutrons, and electrons for any given ion or isotope (DOK 1)
C4.10B Recognize that an element always contains the same number of protons (DOK 1)

C4.10c Calculate the average atomic mass of an element given the percent abundance and mass of the individual isotopes (DOK 1)
C4.10d Predict which isotope will have the greatest abundance given the possible isotopes for an element and the average atomic mass in the periodic table (DOK 2)
C4.10e Write the symbol for an isotope, XZA, where Z is the atomic number, A is the mass number, and X is the symbol for the element (DOK 1)
C5.2g Calculate the number of atoms present in a given mass of element (DOK 1)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. In the fourth century BCE, the Greek philosopher Democritus suggested that the universe was made of indivisible units called atoms. 2. According to Dalton, all atoms of a given element were exactly alike, and atoms of different elements could join to form compounds. 3. Thomson's cathode-ray tube experiment suggested that cathode rays were made of negatively charged particles that came from inside atoms. 4. Rutherford proposed that most of the mass of the atom was concentrated at the atom's center. 5. The three main subatomic particles are distinguished by mass, charge, and location in the atom. 6. Atoms of each element have the same number of protons, but they can have different numbers of neutrons. 7. Isotopes of an element vary in mass because their numbers of neutrons differ. 8. Because working with such tiny masses is difficult, atomic masses are usually expressed in unified atomic mass units. 9. In the modern atomic model, electrons can be found only in certain energy levels, not between levels. Furthermore, the location of electrons cannot be predicted precisely 10. The number of energy levels that are filled in an atom depends on the number of electrons. 11. Electrons jump between energy levels when an atom gains or loses energy. **The following vocabulary words:** 12. <u>Law of definite proportions</u>: A chemical compound always contains the same elements in exactly the same proportions by	1. Recite the first theory of atoms 2. Explain what Dalton added to the atomic theory 3. Show how Thomson discovered the electron 4. Explain Rutherford's atomic model 5. Define the difference between protons, neutrons, and electrons 6. Show what atoms of an element have in common with other atoms of the same element 7. Determine why isotopes of the same element have different atomic masses 8. Define the unit used to express atomic mass 9. Diagram the modern model of the atom for elements 1-20 10. Explain/diagram are the energy levels of an atom filled (including s, p, d, & f sublevels) 11. Explain what makes an electron jump to a new energy level

weight or mass. 13. electron: a subatomic particle that has a negative charge 14. nucleus: an atom's central region, which is made up of protons and neutrons 15. atomic number: the number of protons in the nucleus of an atom 16. mass number: the sum of the numbers of protons and neutrons in the nucleus of an atom 17. radioisotopes: unstable isotopes that emit radiation and decay into other isotopes 18. unified atomic mass unit(AMU): a unit of mass that describes the mass of an atom or molecule; it is exactly 1/12 the mass of a carbon atom with mass number 12 (symbol, u) 19. mole: the SI base unit used to measure the amount of a substance whose number of particles is the same as the number of atoms of carbon in exactly 12 g of carbon-12 (abbreviation, mol) 20. molar mass: the mass in grams of one mole of a substance 21. orbital: a region in an atom where there is a high probability of finding electrons 22. valence electron: an electron that is found in the outermost shell of an atom and that determines the atom's chemical properties	

Phase II Curriculum

Unit: The Periodic Table

Essential Questions:	**Essential Understanding:**
● How is the periodic table organized? ● Explain how to use the periodic table to obtain information. ● What is the difference between metals, nonmetals, and metalloids? ● What are the properties of a typical metal? ● Where are the alkali metals and alkaline earth metals found? ● How are the three groups of transition elements different? ● How would you classify hydrogen? ● Compare and contrast properties of the halogens. ● Describe properties and uses of the noble gases. ● Distinguish among metals, nonmetals, and metalloids. ● What are allotropes? ● In what ways can the crystal structure of carbon be different? ● What are synthetic elements and why are they important?	● Atoms of elements that are in the same group or family on the periodic table contain the same number of outer (valence) electrons ● Atoms of elements that are in the period on the periodic table contain the same number of electron energy levels ● Elements can be classified into three main types - metals, nonmetals, and metalloids. ● Metals are located on the left side of the periodic table and are generally shiny, good conductors, malleable, and ductile ● Nonmetals are located on the right side of the periodic table and are generally are dull, poor conductors, and brittle ● Some groups on the periodic table contain metalloids (elements that share some properties of both metals and nonmetals) ● Metals are located on the left side of the periodic table and are generally shiny, good conductors, malleable, and ductile ● Nonmetals are located on the right side of the periodic table and are generally are dull, poor conductors, and brittle ● Some groups on the periodic table contain metalloids (elements that share some properties of both metals and nonmetals)

Curriculum Standards- DOK noted where applicable with Standards

C1.1C Conduct scientific investigations using appropriate tools and techniques (DOK 2)
C1.1D Identify patterns in data and relate them to theoretical models (DOK 2)
C1.1E Describe a reason for a given conclusion using evidence from an investigation (DOK 3)
C1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation (DOK 3)
C1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables (DOK 3)
C4.3h Explain properties of various solids such as malleability, conductivity, and melting point in terms of the solid's structure and bonding (DOK 1)
C4.8D Give the number of electrons and protons present if the fluoride ion has a -1 charge (DOK 1)
C4.8e Write the complete electron configuration of elements in the first four rows of the periodic table (DOK 1)

C4.9A Identify elements with similar chemical and physical properties using the periodic table (DOK 1)
C4.9b Identify metals, non-metals, and metalloids using the periodic table (DOK 1)
C4.9c Predict general trends in atomic radius, first ionization energy, and electonegativity of the elements using the periodic table. (DOK 1)
C4.10A List the number of protons, neutrons, and electrons for any given ion or isotope.(DOK 1)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. In his periodic table, Mendeleev arranged elements in rows by increasing atomic mass. 2. The modern periodic table organizes elements by atomic number. When the elements are arranged in this way, elements that have similar properties appear at regular intervals. 3. The periodic trends in the periodic table are the result of electron arrangement. 4. If an atom gains or loses electrons, it no longer has an equal number of electrons and protons. Because the charges do not cancel completely, the atom has a net electric charge. 5. All elements are either metals, nonmetals, or semiconductors. 6. In general, the elements in a family have the same number of valence electrons. 7. Families of metals include the alkali metals, the alkaline-earth metals,and the transition metals. 8. Families of nonmetals include the noble gases and the halogens. 9. As their name suggests, semiconductors are able to conduct heat and electricity under certain conditions. **The following vocabulary words:** 10. periodic law: the law that states that the repeating chemical and physical properties of elements change periodically with the atomic numbers of the elements 11. group: a vertical column of elements in the periodic table; elements in a group share chemical properties 12. metal: an element that is shiny and that conducts heat and electricity well 13. nonmetal: an element conducts heat and electricity poorly 14. semiconductor (or metalloid): an element or	1. Explain how Mendeleev arranged the elements in his periodic table 2. Explain how elements are arranged in the modern periodic table 3. Explain how electron arrangement causes elements within a group of the periodic table to have similar chemical properties 4. Determine what happens to an atom that gains or loses electrons 5. Define the three main categories of elements and give examples of each 6. Determine what each element family has in common 7. Define the families of metals 8. List some of the families of nonmetals 9. Explain semiconductors and show how they are different from metals or nonmetals

compound that conducts electric current better than an insulator does but not as well as a conductor does 15. alkali metal: one of the elements of Group 1 of the periodic table 16. alkaline-earth metal: one of the elements of Group 2 of the periodic table 17. transition metal: one of the metals that can use the inner shell before using the outer shell to bond 18. noble gas: one of the elements of Group 18 of the periodic table 19. halogen: one of the elements of Group 17 of the periodic table	

Phase II Curriculum

Unit: The Structure of Matter

Essential Questions:	**Essential Understanding:**
● How does a compound differ from its component elements? ● What does a chemical formula represent? ● How do electron dot diagrams help predict chemical bonding? ● Why does chemical bonding occur? ● What are ionic bonds and covalent bonds? ● Which particles are produced by different types of bonding? ● How do nonpolar and polar covalent bonds compare? ● How are oxidation numbers determined? ● How are formulas for ionic and covalent compounds written? ● How are ionic and covalent compounds named? ● What is the difference between organic and inorganic compounds? ● Why can carbon form so many different compounds? ● What is the difference between a saturated and unsaturated hydrocarbon? ● What are isomers and how do their properties vary? ● What is a substituted hydrocarbon? ● What are the properties and uses of some common substituted hydrocarbons? ● What are aromatic compounds? ● How are organic compounds obtained from petroleum? ● How do organic compounds combine to form polymers? ● What are some uses of polymers? ● How are the structures of proteins, carbohydrates, lipids, and nucleic acids similar? How are they different? ● What types of polymers are found in the basic food groups? ● What is the function of DNA?	● When atoms form compounds, each atom is more stable in the compound than it was by itself ● Atoms form ionic bonds by transferring electrons and form covalent bonds by sharing electrons ● The oxidation numbers of the ions in ionic compounds determine the formula of the compounds ● Just over 110 elements combine with chemical bonds to form nearly an infinite number of compounds ● Most compounds containing the element carbon are organic compounds. ● Hydrocarbons are compounds made only of carbon and hydrogen atoms ● Substituted hydrocarbons contain other elements besides carbon and hydrogen ● Petroleum is the source of carbon compounds used to make plastics, fossil fuels, and many other products ● Proteins, nucleic acids, carbohydrates, and lipids are polymers made by plants and animals.

Curriculum Standards- DOK noted where applicable with Standards

C2.1c Compare qualitatively the energy changes associated with melting various types of solids in terms of the types of forces between the particles in the solid; (DOK 2)
P4.p2D Recognize that the properties of a compound differ from those of its individual elements.(DOK P)
C3.2b Describe the relative strength of single, double, and triple covalent bonds between nitrogen atoms;(DOK 1)
C4.1a Calculate the percent by weight of each element in a compound based on the compound formula;(DOK 1)
C4.1b Calculate the empirical formula of a compound based on the percent by weight of each element in the compound;(DOK 1)
C4.1c Use the empirical formula and molecular weight of a compound to determine the molecular formula;(DOK 1)
C4.2A Name simple binary compounds using their formulae;(DOK 1)
C4.2B Given the name, write the formula of simple binary compounds;(DOK 1)
C4.2c Given a formula, name the compound;(DOK 1)
C4.2d Given the name, write the formula of ionic and molecular compounds;(DOK 1)
C4.2e Given the formula for a simple hydrocarbon, draw and name the isomers; (DOK 1)
C4.3A Recognize that substances that are solid at room temperature have stronger attractive forces than liquids at room temperature, which have stronger attractive forces than gases at room temperature;(DOK 1)
C4.3c Compare the relative strengths of forces between molecules based on the melting point and boiling point of the substances;(DOK 2)
C4.3d Compare the strength of the forces of attraction between molecules of different elements;(DOK 2)
C4.3e Predict whether the forces of attraction in a solid are primarily metallic, covalent, network covalent, or ionic based upon the elements' location on the periodic table;(DOK 2)
C4.3f Identify the elements necessary for hydrogen bonding;(DOK 1)
C4.3g Given the structural formula of a compound, indicate all the intermolecular forces present;(DOK 1)
C4.3h Explain properties of various solids such as malleability, conductivity, and melting point in terms of the solid's structure and bonding;(DOK 1)
C4.3i Explain why ionic solids have higher melting points than covalent solids;(DOK 1)
C4.4a Explain why at room temperature different compounds can exist in different phases;(DOK 2)
C4.8f Write kernel structures for main group elements;(DOK 1)
C4.8g Predict oxidation states and bonding capacity for main group elements using their electron structure; (DOK 2)
C5.4B Measure, plot, and interpret the graph of the temperature versus time of an ice-water mixture, under slow heating, through melting and boiling.(DOK 2)
C5.4c Explain why both the melting point and boiling points for water are significantly higher than other small molecules of comparable mass;(DOK 2)
C5.4e Compare the melting point of covalent compounds based on the strength of IMFs;(DOK 2)
C5.5A Predict if the bonding between two atoms of different elements will be primarily ionic or covalent;(DOK 2)
C5.5c Draw Lewis structures for simple compounds;(DOK 1)
C5.5d Compare the relative melting point, electrical and thermal conductivity and hardness for ionic, metallic, and covalent compounds(DOK 2)
C5.5e Relate the melting point, hardness, and electrical and thermal conductivity of a substance to its structure; (DOK 2)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**

1. The forces that hold atoms or ions together in a compound are called chemical bonds.
2. The structure of chemical compounds can be shown by various models. Different models show different aspects of compounds.
3. The chemical structure of a compound determines the properties of that compound.
4. Generally, atoms join to form bonds so that each atom has a stable electron configuration
5. .Ionic bonds form from the attractions between such oppositely charged ions.
6. Atoms joined by covalent bonds share electrons.
7. Metals are flexible and conduct electric current well because their atoms and electrons can move freely throughout a metal's packed structure.
8. A polyatomic ion acts as a single unit in a compound, just as ions that consist of a single atom do.
9. The names of ionic compounds consist of the names of the ions that make up the compounds.
10. For covalent compounds of two elements, numerical prefixes tell how many atoms of each element are in the molecule.
11. An empirical formula tells us the smallest whole-number ratio of atoms that are in a compound.
12. An organic compound is a covalently bonded compound that contains carbon.
13. A polymer is a molecule that is a long chain made of smaller molecules.
14. Biochemicals, which are essential to life, include carbohydrates,proteins, and DNA.

The following vocabulary words:

15. chemical bond: the attractive force that holds atoms or ions together
16. bond length: the average distance between the nuclei of two bonded atoms
17. bond angle: the angle formed by two bonds to the same atom
18. ionic bonds: the attractive force between oppositely charged ions, which form when electrons are transferred from one atom to another
19. covalent bond: a bond formed when atoms share one or more pairs of electrons.
20. nonpolar covalent bonds: bonds in which electrons are shared equally
21. polar covalent bond: a bond in which there is an unequal sharing of electrons
22. metallic bond: a bond formed by the attraction

1. Explain what holds a compound together
2. Describe/draw how the structure of chemical compounds can be shown
3. Determine the properties of a compound
4. Explain why atoms form bonds
5. Show how ionic bonds form
6. Explain how covalently bonded compounds share electrons
7. Explain what gives metals their distinctive properties
8. Show how polyatomic ions are similar to other ions
9. Name any ionic compound
10. Explain what the numerical prefixes used in naming covalent compounds tell you
11. Explain what a compound's empirical formula indicates
12. Define an organic compound
13. Explain what a polymer is and give examples
14. Determine which organic compounds are essential to life

between positively charged metal ions and the electrons around them 23. polyatomic ion: an ion made of two or more atoms 24. empirical formula: the composition of a compound in terms of the relative numbers and kinds of atoms in the simplest ratio 25. molecular formula: a chemical formula that shows the number and kinds of atoms in a molecule, but not the arrangement of atoms	

Phase II Curriculum

Unit: Chemical Reactions

Essential Questions:	**Essential Understanding:**
● What are the reactants and products in a chemical reaction? ● Is mass conserved in a chemical reaction? ● Why are chemical reaction important? ● How do you balance a chemical equation? ● What are the five general types of chemical reactions? ● How can you predict if a metal will replace another in a compound? ● What do the terms oxidation and reduction mean? ● How can the source of energy changes in chemical reactions be identified? ● How do exergonic and endergonic reactions compare? ● Is energy conserved during a chemical reaction? ● How do chemists express the rates of chemical reactions? ● How do catalysts and inhibitors affect reaction rates?	● The rearrangement of atoms in a chemical change is described by a chemical equation ● A balanced chemical equation contains the same number and types of atoms in the reactants as in the products ● Reactions can be classified based on how atoms are rearranged ● Exergonic reactions release energy and endergonic reactions absorb energy ● A chemical reaction involves changing one or more substances into a different substance or substances.

Curriculum Standards- DOK noted where applicable with Standards

C2.1a Explain the changes in potential energy as a chemical bond forms and use this to explain why bond breaking always requires energy;(DOK 2)
C2.1b Describe energy changes associated with chemical reactions in terms of bonds broken and formed; (DOK 1)
C2.3a Explain how the rate of a given chemical reaction is dependent on the temperature and the activation energy; (DOK 1)
C2.3b Draw and analyze a diagram to show the activation energy for an exothermic reaction that is very slow at room temperature;(DOK 2)
C3.2a Describe the energy changes in photosynthesis and in the combustion of sugar in terms of bond breaking and bond making;(DOK 1)
C3.3c Explain why it is necessary for a molecule to absorb energy in order to break a chemical bond;(DOK 2)
C3.4A Use the terms endothermic and exothermic correctly to describe chemical reactions in the laboratory; (DOK 1)
C3.4B Explain why chemical reactions will either release or absorb energy;(DOK 2)
C3.4c Write chemical equations including the heat term as a part of equation or using ÄH notation;(DOK 1)
C3.4d Draw enthalpy diagrams for reactants and products in endothermic and exothermic reactions;(DOK 1)

C3.4f Explain why some endothermic reactions are spontaneous at room temperature;(DOK 2)
P3.p2A Trace energy transfers involving various types of energy including nuclear, chemical, electrical, sound, and light.(DOK P)
C5.2A Balance simple chemical equations applying the conservation of matter;(DOK 2)
C5.2d Calculate the mass of a particular compound formed from the masses of starting materials;(DOK 1)
C5.2e Identify the limiting reagent when given the masses of more than one reactant.(DOK 2)
C5.3a Describe equilibrium shifts in a chemical system caused by changing conditions;(DOK 1)
C5.3b Predict shifts in a chemical system caused by changing conditions;(DOK 2)
C5.3c Predict the extent reactants are converted to products using the value of the equilibrium constant;(DOK 2)
C5.r1a Predict how the rate of a chemical reaction will be influenced by changes in concentration, and temperature, pressure;(DOK R)
C5.r1b Explain how the rate of a reaction will depend on concentration, temperature, pressure, and nature of reactant;(DOK R)
C5.6a Balance half-reactions and describe them as oxidations or reductions;(DOK 2)
C5.6b Predict single replacement reactions;(DOK 1)
C5.6c Explain oxidation occurring when two different metals are in contact;(DOK 1)
C5.6d Calculate the voltage for spontaneous redox reactions from the standard reduction potentials;(DOK 1)
E2.4B Explain how the impact of human activities on the environment can be understood through the analysis of interactions between the four Earth systems; (DOK 2)
E2.4c Explain ozone depletion in the stratosphere and methods to slow human activities to reduce ozone depletion; (DOK 1)
E4.p2A Describe the composition and layers of the atmosphere. (DOK P)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. Chemical reactions occur when substances undergo chemical changes to form new substances. 2. Chemical reactions always involve changes in energy. 3. A chemical equation uses symbols to represent a chemical reaction and shows the relationship between the reactants and products of a reaction. 4. A balanced equation tells you the mole ratio, or proportion of reactants and products, in a chemical reaction. 5. You can use patterns to identify kinds of chemical reactions and to predict the products of the chemical reactions. 6. Free-radical reactions and redox reactions can be understood as changes in the numbers of electrons that atoms have. 7. Anything that increases contact between particles will increase the rate of a reaction. 8. A catalyst speeds up or slows down a reaction but is not changed by the reaction.	1. Determine if a chemical reaction will take place 2. Explain the role of energy in chemical reactions 3. Explain what a chemical equation is 4. Show how to balance a chemical equation 5. Explain how learning about reaction types helps in understanding chemical reactions 6. Explain: in which kinds of chemical reactions do the numbers of electrons in atoms change 7. Describe the kinds of things that speed up a reaction 8. Explain what a catalyst does 9. Describe what happens when a reaction goes backward as well as forward

9. Some processes may go in both directions, which results in an equilibrium system.

The following vocabulary words:

10. product: a substance that forms in a chemical reaction
11. reactant: a substance or molecule that participates in a chemical reaction
12. chemical energy: the energy released when a chemical compound reacts to produce new compounds
13. exothermic reaction: a chemical reaction in which energy is released to the surroundings as heat
14. endothermic reaction: a chemical reaction that requires energy input
15. chemical equation: a representation of a chemical reaction that uses symbols to show the relationship between the reactants and the products
16. Mole ratio: the relative number of moles of the substances required to produce a given amount of product in a chemical reaction
17. synthesis reaction: is a reaction in which two or more substances combine to form a new compound.
18. decomposition reaction: a reaction in which a single compound breaks down to form two or more simpler substances
19. combustion reaction: the oxidation reaction of an organic compound, in which heat is released
20. single-displacement reaction: a reaction in which one element or radical takes the place of another element or radical in a compound
21. double-displacement reaction: a reaction in which a gas, a solid precipitate, or a molecular compound forms from the apparent exchange of atoms or ions between two compounds
22. oxidation-reduction reaction: any chemical change in which one species is oxidized (loses electrons) and another species is reduced (gains electrons); also called redox reaction
23. free radical: an atom or a group of atoms that has one unpaired electron
24. catalyst: substance that changes the rate of a chemical reaction without being consumed or changed significantly
25. inhibitors: substances that slow reactions
26. enzyme: a type of protein that speeds up metabolic reactions in plants and animals without being permanently changed or

destroyed 27. substrate: the reactant in reactions catalyzed by enzymes 28. Le Châtelier's principle:If a change is made to a system in chemical equilibrium, the equilibrium shifts to oppose the change until a new equilibrium is reached.	

Phase II Curriculum

Unit: Solutions

Essential Questions:	**Essential Understanding:**
● How do substances dissolve in a liquid? ● How do solid solutions and gas solutions form? ● What factors affect the rates at which solids dissolve in liquids? ● How are the concentrations of solutions expressed? ● What is solubility? ● What are saturated, unsaturated, and supersaturated solutions? ● How do pressure and temperature affect the solubility of gases? ● Why do some solutions conduct electricity? ● What are two ways that some solutes form ions in solution? ● How do solutes affect the freezing and boiling points of solvents? ● What solutes do not dissolve well in water? ● How does polarity affect solubility? ● How does soap work?	● A solution forms when particles of solute become evenly mixed among particles of solvent. ● Solubility is the maximum amount of solute that can dissolve and concentration is the amount of solute actually dissolved in a given amount of solute ● Dissolved particles can both lower the freezing point and raise the boiling point of a solution ● Nonpolar solvents can dissolve many nonpolar solutes

Curriculum Standards- DOK noted where applicable with Standards

C1.2B Identify and critique arguments about personal or societal issues based on scientific evidence;(DOK 3)
C1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.(DOK 3)
C1.2D Evaluate scientific explanations in a peer review process or discussion format;(DOK 3)
C1.2f Critique solutions to problems, given criteria and scientific constraints;(DOK 3)
C1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions;(DOK 2)
C3.4g Explain why gases are less soluble in warm water than cold water;(DOK 1)
C4.3f Identify the elements necessary for hydrogen bonding;(DOK 1)
C4.4b Identify if a molecule is polar or nonpolar given a structural formula for the compound;(DOK 1)
C4.7a Investigate the difference in the boiling point or freezing point of pure water and a salt solution.(DOK 2)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**

1. A heterogeneous mixture does not have a fixed composition.
2. A homogeneous mixture looks uniform even when you examine it under a microscope because the individual components of the mixture are too small to be seen.
3. Water is called the universal solvent because many substances can dissolve in water.
4. The energy transferred from the solvent to the solute, as well as the attractive forces between the solvent and solute molecules, causes molecules at the surface of the crystal to dissolve.
5. The solubility of a substance is the maximum mass of a solute that can dissolve in 100 g of solvent at a certain temperature and standard atmospheric pressure.
6. In a saturated solution, the dissolved solute is in equilibrium with undissolved solute. So, if you add more solute, it just settles to the bottom of the container.

The following vocabulary words:

7. suspension: a mixture in which particles of a material are more or less evenly dispersed throughout a liquid or gas
8. decanting: process of pouring a less dense liquid off a denser liquid
9. colloid: a mixture consisting of tiny particles that are intermediate in size between those in solutions and those in suspensions and that are suspended in a liquid, solid or gas
10. emulsion: any mixture of two or more immiscible liquids in which one liquid is dispersed in the other
11. solution: a homogeneous mixture throughout which two or more substances are uniformly dispersed
12. solute: In a solution, the substance that dissolves in the solvent
13. solvent: in a solution, the substance in which the solute dissolves
14. miscible: liquids that form a single layer when mixed
15. distillation: a method used to separate miscible liquids that have different boiling points
16. petroleum: a liquid solution of gasoline, diesel fuel, and kerosene
17. amalgam: a solution of mercury dissolved in silver
18. alloy: a solid or liquid mixture of two or more metals
19. polar: describes a molecule in which the

1. Determine if something is a heterogeneous mixture
2. Determine if something is a homogeneous mixture
3. Explain why water is called the universal solvent
4. Explain why some substances dissolve but others don't
5. Define solubility
6. Explain what happens when you add more solute to a saturated solution

positive and negative charges are separated

20. hydrogen bond: the intermolecular force occurring when a hydrogen atom that is bonded to a highly electronegative atom of one molecule is attracted to two unshared electrons of another molecule
21. nonpolar: describes a molecule in which the centers of positive and negative charge are not separated
22. solubility: the ability of one substance to dissolve in another at a given temperature and pressure
23. concentration: the amount of a particular substance in a given volume of a mixture or solution,
24. saturated solution: a solution that cannot dissolve any more solute under the given conditions
25. unsaturated solution: a solution that contains less solute than a saturated solution does and that is able to dissolve additional solute
26. supersaturated solution: a solution that holds more dissolved solute than is required to reach equilibrium at a given temperature.
27. molarity: a concentration unit of a solution expressed in moles of solute dissolved per liter of solution.

Phase II Curriculum

Unit: Acids, Bases & Salts

Essential Questions:	**Essential Understanding:**
● What defines an acid or base? ● How are common acids and bases used? ● How do acids and bases form ions in solution? ● What determines the strength of an acid or base? ● How effectively do different acids and bases conduct electricity? ● What is the difference between strength and concentration? ● What is a neutralization reaction? ● What is a salt, and how does it form? ● What is the purpose of the indicator in a titration? ● How do soaps and detergents differ?	● Acids produce hydronium ions in water ● Bases produce hydroxide ions in water ● Acid strength describes the ease with which an acid dissociates into ions. ● Acid concentration describes the amount of acid dissolved in water ● An acid and a base react to form a salt and water ● Some substances can be classified as acids, bases, or salts.

Curriculum Standards- DOK noted where applicable with Standards

C1.1C Conduct scientific investigations using appropriate tools and techniques;(DOK 2)
C1.1E Describe a reason for a given conclusion using evidence from an investigation;(DOK 3)
C1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation;(DOK 3)
C1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables;(DOK 3)
C1.2D Evaluate scientific explanations in a peer review process or discussion format;(DOK 3)
C5.7A Recognize formulas for common inorganic acids, carboxylic acids, and bases formed from families I and II;(DOK 1)
C5.7B Predict products of an acid-base neutralization.(DOK 2)
C5.7C Describe tests that can be used to distinguish an acid from a base.(DOK 1)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. Acids taste sour, cause indicators to change color, and conduct electric current. They are	1. List/define the properties of acids 2. List/define the properties of bases

also corrosive and can damage materials, including your skin. 2. Bases have a bitter taste, and solutions of bases feel slippery. Solutions of bases also conduct electric current, cause indicators to change color, and can damage the skin. 3. The pH of a solution indicates its concentration of H3O+ ions. In solutions, the concentration of hydronium ions is related to the concentration of hydroxide ions, OH–. The pH of a solution also indicates the concentration of OH– ions. 4. A neutralization reaction is the reaction between an acid and a base. 5. To a chemist, a salt can be almost any combination of cations and anions, except hydroxides and oxides, which are bases. 6. Water does not mix with grease or oil. Cleaning products improve water's ability to clean because they help water mix with oily substances. 7. Many healthcare, beauty, and food products in your home, in addition to cleaners, contain acids, bases, or salts. **The following vocabulary words:** 8. <u>acid:</u> any compound that increases the number of hydronium ions, H3O+, when dissolved in water 9. <u>indicator</u>: a compound that can reversibly change color depending on conditions such as pH 10. <u>electrolyte:</u> a substance that dissolves in water to give a solution that conducts an electric current 11. <u>base:</u> any compound that increases the number of hydroxide ions, OH–, when dissolved in water 12. <u>pH</u>: a value that is used to express the acidity or basicity of a system 13. <u>neutralization reaction</u>: the reaction of the ions that characterize acids and the ions that characterize bases to form water molecules and a salt 14. <u>salt:</u> an ionic compound that forms when a metal atom or a positive radical replaces the hydrogen of an acid 15. <u>titration:</u> the process of adding carefully measured amounts of one solution to another solution 16. <u>equivalence point</u>: the point when the original amount of acid equals the original amount of base added 17. <u>soap</u>: a substance that is used as a cleaner	3. Determine how pH is related to the concentration of hydronium ions and hydroxide ions in solution 4. Define a neutralization reaction and determine what the products will be 5. Define and give examples of common salts 6. Explain why cleaning products added to water 7. List several household products that contain acids, bases, and salts

and that dissolves in water 18. detergent: a water-soluble cleaner that can emulsify dirt and oil 19. bleach: a chemical compound used to whiten or make lighter 20. disinfectant: a chemical substance that kills harmful bacteria or viruses 21. antacid: a weak base that neutralizes stomach acid	

Phase II Curriculum

Unit: Nuclear Changes

Essential Questions:	**Essential Understanding:**
● What force holds the atomic nucleus together? ● What is radioactivity? ● How are the properties of radioactive and stable nuclei different? ● Explain how radioactivity was first discovered. ● What are alpha, beta, and gamma particles? ● How do you determine the half-life of a radioactive material? ● How is nuclear fission different than nuclear fusion? ● Describe the process of radioactive dating. ● How do cloud and bubble chambers detect radioactivity? ● Explain how an electroscope can be used to detect radiation. ● How does a Geiger counter measure nuclear radiation?	● The repulsive electrical force between protons causes some nuclei to be unstable ● Unstable nuclei can emit particles and energy while they decay ● Nuclear radiation produces charged particles in matter that can be detected ● Nuclear fission splits nuclei apart and nuclear fusion joins nuclei together ● Protons and neutrons are held together in a nucleus by the strong nuclear force.

Curriculum Standards- DOK noted where applicable with Standards

C1.2i Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge;(DOK 2)
C1.2k Analyze how science and society interact from a historical, political, economic, or social perspective; (DOK 2)
C2.5a Determine the age of materials using the ratio of stable and unstable isotopes of a particular type;(DOK 1)
C2.r5b Illustrate how elements can change in nuclear reactions using balanced equations;(DOK R)
C2.r5c Describe the potential energy changes as two protons approach each other;(DOK R)
C2.r5d Describe how and where all the elements on earth were formed;(DOK R)
C3.5a Explain why matter is not conserved in nuclear reactions;(DOK 1)
C4.8C Recognize that protons repel each other and that a strong force needs to be present to keep the nucleus intact; (DOK 1)
E2.2A Describe the Earth's principal sources of internal and external energy; (DOK 1)
E5.2C Describe how nuclear fusion produces energy in the Sun; (DOK 1)
E5.3e Determine the approximate age of a sample, when given the half-life of a radioactive substance along with the ratio of daughter to parent substances present in the sample; (DOK 2)
E5.3f Explain why C-14 can be used to date a 40,000 year old tree, but U-Pb cannot. (DOK 2)
P3.p2A Trace energy transfers involving various types of energy including nuclear, chemical, electrical, sound, and light;(DOK P)
P4.12A Describe peaceful technological applications of nuclear fission and radioactive decay;(DOK 1)

P4.12C Explain how stars, including our Sun, produce huge amounts of energy;(DOK 1)
P4.12d Identify the source of energy in fission and fusion nuclear reactions.(DOK 1)
ratio of daughter to parent substances present in the sample;(DOK 1)

LEARNING TARGETS

Knowledge/Content **I Know …**	**Skills/Processes** **I Can …**
1. After radioactive decay, the element changes into a different isotope of the same element or into an entirely different element. 2. Anytime that an unstable nucleus emits alpha or beta particles, the number of protons or neutrons changes. 3. It is impossible to predict the moment when any particular nucleus will decay, but it is possible to predict the time required for half of the nuclei in a given radioactive sample to decay. 4. The stability of a nucleus depends on the nuclear forces that hold the nucleus together. These forces act between the protons and the neutrons. 5. In the fission process, when the nucleus splits, both neutrons and energy are released 6. .Energy can be obtained when very light nuclei are combined to form heavier nuclei. 7. We are continually exposed to radiation from natural sources, such as the sun, soil, rocks, and plants. 8. Some common applications of nuclear radiation include medical diagnosis and treatment, smoke detectors, manufacturing, and agriculture. 9. The risk of damage from nuclear radiation depends on both the type and the amount of radiation exposure 10. .Energy produced from fission is used to provide electrical energy to millions of homes and businesses. **The following vocabulary words:** 11. radioactive decay: the disintegration of an unstable atomic nucleus into one or more different nuclides 12. nuclear radiation: the particles that are released from the nucleus during radioactive decay 13. alpha particle: a positively charged particle that consists of two protons and two neutrons and that is emitted from the nucleus during	1. Determine what happens when an element undergoes radioactive decay 2. Determine how radiation affects the nucleus of an unstable isotope 3. Explain how scientists predict when an atom will undergo radioactive decay 4. Explain what holds the nuclei of atoms together 5. Know what particles are released when the nucleus of a heavy atom is split 6. Explain what happens when the nuclei of small atoms are joined 7. List situations where are we exposed to radiation 8. List several beneficial uses of nuclear radiation 9. List which factors determine the risks of nuclear radiation 10. Explain how energy is produced by nuclear fission or fusion and how it can be used 11. Use the half-life of an element to determine the age of a sample

radioactive decay

14. beta particle: an electron or positron that is emitted from a nucleus during radioactive decay
15. gamma ray: a high-energy photon emitted by a nucleus during fission and radioactive decay
16. half-life: the time required for half of a sample of a radioactive isotope to break down by radioactive decay to form a daughter isotope
17. strong nuclear force: causes protons and neutrons in the nucleus to attract each other
18. fission: the process by which a nucleus splits into two or more fragments and releases neutrons and energy
19. mass defect: the difference in the total measured mass of a nucleus and the sum of the individual masses of the neutrons and protons that make up the nucleus
20. nuclear chain reaction: a continuous series of nuclear fission reactions
21. critical mass: the minimum mass of a fissionable isotope that provides the number of neutrons needed to sustain a chain reaction
22. fusion: the process in which light nuclei combine at extremely high temperatures, forming heavier nuclei and releasing energy