Physical Science (2016)

Wright City R-II
Science
Grade 9, Duration 1 Year, 1 Credit
Required Course

Course Description

This is a general science course where we will explore several topics including: force, motion, work, energy, matter, periodic table, solutions, chemical reactions, earth and it's processes.

Scope and Sequence

Timeframe	Unit	Instructional Topics
6 Week(s)	Motion & Stability : Forces and Interactions	1. Methods of Science 2. Standards of Measurement 3. Communicating with Graphs 4. Describing Motion 5. Velocity and Momentum 6. Acceleration 7. Forces 8. Newton's Laws
6 Week(s)	Energy	1. Calculating Energy 2. Modeling Energy 3. Creation of an energy transferring device 4. Temperature, thermal energy, and heat 5. Conduction, Convection, & Radiation 6. Electric Charge 7. Electric Current 8. Magnetism 9. Electricity & Magnetism 10. Producing an Electric Current
5 Week(s)	Waves and Their Applications in Technologies for Information Transfer	1. Wave Properties 2. Electromagnetic Radiation
6 Week(s)	Matter and its Interactions	1. Atomic Theory 2. Periodic Table 3. Chemical Bonding 4. Develop a Chemical Reaction Model 5. Chemical Reactions 6. Nuclear Process
6 Week(s)	Earth's Place in the Universe	1. The Sun 2. The Big Bang 3. Stellar Evolution 4. The Solar System 5. Plate Tectonics 6. Earth's History 7. Earth's internal and surface processes
6 Week(s)	Engineering, Technology, and Application of Science	1. Engineering Problems 2. Developing Possible Solutions

Prerequisites

Graduate middle school

Course Instructional Resources/Textbook

Textbook: Glencoe "Physical Science with Earth Science"

Course Details

UNIT: Motion & Stability : Forces and Interactions -- 6 Week(s)

Unit Description
In this unit students will explore scientific inquiry, how force affects motion of objects, and how the results of science provide technology that improves everyday life.

Academic Vocabulary
Bias
Constant
Control
Dependent Variable
Independent Variable
Experiment
Hypothesis
Model
Scientific Law
Scientific Method
Theory
Variable
Density
Mass
Matter
SI Unit
Standard
Volume
Graph
Displacement
Motion
Speed
Momentum
Velocity
Acceleration
Field
Force
Friction
gravity
net force
weight
inertia
Newtons laws of motion
air resistance
Centripetal force
free fall
law of conservation of momentum
terminal velocity

TOPIC: Methods of Science -- 4 Day(s)

Description
This topic will discuss what science is, what steps are taken in the scientific method, how models help visualize abstract concepts, what theories and laws are, and what are some limitations of science.

Academic Vocabulary (What terms will students need to know?)
Bias
Constant
Control
Dependent Variable
Independent Variable
Experiment
Hypothesis
Model
Scientific Law
Scientific Method
Theory
Variable

Learning Targets

I can identify the components of scientific inquiry as it is related to experimentation.

I can analyze and evaluate the design of an experiment and critique if necessary.

I can use the critical thinking method to solve problems.

I can understand the difference between a scientific law and a scientific theory.

TOPIC: Standards of Measurement -- 2 Day(s)

Description
This topic will cover units and standards scientist use while measuring various quantities.

Academic Vocabulary (What terms will students need to know?)
Density
mass
matter
SI Unit
Standard
Volume

Learning Targets

I can describe why it is important to have standards in measuring.

TI can understand what each SI Prefix means

I can identify the SI units and symbols for length, volume, mass, density, time, and temperature.

I can convert related SI units.

TOPIC: Communicating with Graphs -- 2 Day(s)

Description
This topic covers how to properly create and use visual representations of numerical data to detect patterns.

Academic Vocabulary (What terms will students need to know?)
Line Graph
Bar Graph
Pie Chart
x-axis
y-axis
Title
Scale

Learning Targets

I can identify the three types of graphs and use them properly.

I can properly express the independent and dependent variables on a graph.

I can calculate momentum and compare two different objects momentums relative to mass and velocity.

TOPIC: Describing Motion -- 2 Day(s)

Description
This topic will cover how to describe the position and speed of an object.

Academic Vocabulary (What terms will students need to know?)
Motion
Displacement
Speed
Reference point
position

Learning Targets

I can recognize motion is happening because of a change in position relative to a reference point.

SC.9-12.PS2.1

I can understanding the difference between distance and displacement.

SC.9-12.PS2.1

I can will be able to calculate speed and understand its relationship with distance and time.

SC.9-12.PS2.1

I can graph speed on a distance-time graph

SC.9-12.PS2.1

TOPIC: Velocity and Momentum -- 3 Day(s)

Description
In this topic students will be able to calculate velocity and momentum and recognize their relationship to each other.

Academic Vocabulary (What terms will students need to know?)
Velocity
Speed
Direction
Momentum
Mass

Learning Targets

I can understand the difference between Speed and velocity
SC.9-12.PS2.2

I can explain how the motion of two objects are relative to each other.
SC.9-12.PS2.2

I can explain why there is friction between two objects and how to reduce it.
SC.9-12.PS2.2

TOPIC: Acceleration -- 2 Day(s)

Description
In this topic students will learn to calculate, graph , and recognize the relationships of acceleration.

Academic Vocabulary (What terms will students need to know?)
Acceleration
Centripetal acceleration

Learning Targets

I can calculate acceleration and understand it's relationship with velocity and time.
SC.9-12.PS2.1

I can understand the three ways an object can accelerate.
SC.9-12.PS2.1

I can understand the similarities and differences between straight line, circular, and projectile motion.
SC.9-12.PS2.1

TOPIC: Forces -- 3 Day(s)

Description
This topic covers what force is, how it is created, and the interactions between forces.

Academic Vocabulary (What terms will students need to know?)
Force
Net force
Friction
Gravity
Field
Weight

Learning Targets

I can understanding how force and motion are related.
SC.9-12.PS2.3

I can calculate net Force
SC.9-12.PS2.3

I can understand the difference between mass and weight.
SC.9-12.PS2.4

I can understand when momentum is conserved.
SC.9-12.PS2.4

TOPIC: Newton's Laws -- 6 Day(s)

Description
This topic will cover Newton's Laws and their real world applications.

Academic Vocabulary (What terms will students need to know?)
Newton's laws of motion
Inertia
Air resistance
terminal velocity
free fall
centripetal force
law of conservation of momentum

Learning Targets

I can explain what inertia is and how it relates to newton's first law.
SC.9-12.PS2.3

I can calculate acceleration using Newton's second law.
SC.9-12.PS2.1

I can explain how forces between interacting objects relate according to Newton's third law.
SC.9-12.PS2.3 SC.9-12.PS2.4

I can relate Newton's first law to real life collisions.
SC.9-12.PS2.3

I can understand the effects of air resistance and ways to reduce it.
SC.9-12.PS2.3 SC.9-12.PS2.4

I can understand when momentum is conserved.
SC.9-12.PS2.2

UNIT: Energy -- 6 Week(s)

Unit Description
This unit will cover the different forms that energy can be transformed through, how energy is related to force, and what conservation of energy means in terms on transfers.

Academic Vocabulary
Compound machine
efficiency
machine
mechanical advantage
simple machine
work
chemical potential energy
elastic potential energy
gravitational potential energy
kinetic energy
potential energy
system
law of conservation of energy
mechanical energy
power
Conduction
convection
radiation
thermal insulator
charging by contact
charging by induction
conductor
electric field
electroscope
insulator
law of conservation of charge
static energy
Fossil fuel
nonrenewable resources
petroleum
fission
fusion
nuclear reactor
nuclear waste
biomass
geothermal energy
hydroelectricity
photovoltaic cell
renewable resource
acid precipitation
carrying capacity
hazardous waste
photochemical smog
pollutant
population

TOPIC: Calculating Energy -- 3 Day(s)

Description
In this topic the student will learn how to create a computational model to calculate the change in the energy of one component in a system when the changes in energy are known.

Academic Vocabulary (What terms will students need to know?)
work
machine
simple machine
compound machine
efficiency
mechanical advantage
Energy
thermal energy
kinetic energy
gravitational energy
magnetic energy
electrical energy

Learning Targets

I can identify and describe the components to be computationally modeled, including the following: The boundaries of the system, the initial energies of the system's components, the energy flows into or out of the system, and the final energies of the system components.
SC.9-12.PS3.1

I can use the algebraic descriptions of the initial and final energy states of the system, along with the energy flows to create a computational model (e.g., simple computer program, spreadsheet, simulation software package application) that is based on the principle of the conservation of energy.
SC.9-12.PS3.1

I can use the computational model to calculate changes in the energy of one component of the system when changes in the energy of the other components and the energy flows are known.
SC.9-12.PS3.1

I can use the computational model to predict the maximum possible change in the energy of one component of the system for a given set of energy flows.
SC.9-12.PS3.1

I can identify and describe the limitations of the computational model, based on the assumptions that were made in creating the algebraic descriptions of energy changes and flows in the system.
SC.9-12.PS3.1

TOPIC: Modeling Energy -- 3 Day(s)

Description
In this topic the student will learn how to develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

Academic Vocabulary (What terms will students need to know?)
energy
system
kinetic energy
potential energy
elastic potential energy
chemical potential energy
gravitational potential energy

Learning Targets

I can develop models in which they identify and describe the relevant components, including the following:
o All the components of the system and the surroundings, as well as energy flows between the system and the surroundings
o Clear depictions of both a macroscopic and a molecular/atomic-level representation of the system
o Depictions of the forms in which energy is manifested at two different scales:
Macroscopic, such as motion, sound, light, thermal energy, potential energy, or energy in fields
Molecular/atomic, such as motions (kinetic energy) of particles (e.g., nuclei and electrons), the relative positions of particles in fields (potential energy), and energy in fields
SC.9-12.PS3.2

Students describe the relationships between components in their models, including the following:
o Changes in the relative position of objects in gravitational, magnetic, or electrostatic fields can affect the energy of the fields (e.g., charged objects moving away from each other change the field energy).
o Thermal energy includes both the kinetic and potential energies of particle vibrations in solids or molecules and the kinetic energy of freely moving particles (e.g., inert gas atoms, molecules) in liquids and gases.
o The total energy of the system and surroundings is conserved at a macroscopic and molecular/atomic level.
o Chemical energy can be considered in terms of systems of nuclei and electrons in electrostatic fields (bonds).
o As one form of energy increases, others must decrease by the same amount as energy is transferred among and between objects and fields.
SC.9-12.PS3.2

I can use a models to show that in closed systems the energy is conserved on both the macroscopic and molecular/atomic scales so that as one form of energy changes, the total system energy remains constant, as evidenced by the other forms of energy changing by the same amount or changes only by the amount of energy that is transferred into or out of the system.
SC.9-12.PS3.2

I can use a models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles/objects and energy associated with the relative positions of particles/objects on both the macroscopic and microscopic scales.
SC.9-12.PS3.2

TOPIC: Creation of an energy transferring device -- 2 Day(s)

Description
In this topic the student will learn to design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Academic Vocabulary (What terms will students need to know?)
law of conservation of energy
mechanical energy
power

Learning Targets

I can design a device that converts one form of energy into another form of energy.
SC.9-12.PS3.3

I can develop a plan for the device in which they
o identify which scientific principles provide the basis for the energy conversion design;
o identify the forms of energy that will be converted from one form to another in the designed system;
o identify losses of energy by the design system to the surrounding environment;
o describe the scientific rationale for choices of materials and structure of the device, including how student-generated evidence influenced the design; and
o describe that this device is an example of how the application of scientific knowledge and engineering design can increase benefits for modern civilization while decreasing costs and risk.
SC.9-12.PS3.3

I can describe and quantify (when appropriate) prioritized criteria and constraints for the design of the device, along with the trade-offs implicit in these design solutions.
SC.9-12.PS3.3

I can build and test the device according to the plan.
SC.9-12.PS3.3

I can systematically and quantitatively evaluate the performance of the device against the criteria and constraints.
SC.9-12.PS3.3

I can use the results of the tests to improve the device performance by increasing the efficiency of energy conversion, keeping in mind the criteria and constraints, and noting any modifications in tradeoffs.
SC.9-12.PS3.3

TOPIC: Temperature, thermal energy, and heat -- 3 Day(s)

Description
This topic will connect particle motion to temperature, thermal energy and heat and how to measure it.

Academic Vocabulary (What terms will students need to know?)
Temperature
thermal energy
heat
specific heat

Learning Targets

I can describe what temperature is and how it relates to kinetic energy.
SC.9-12.PS3.4

I can show how thermal energy and temperature are related.
SC.9-12.PS3.4

I can explain the difference between thermal energy and heat.
SC.9-12.PS3.4

I can calculate changes in thermal energy.
SC.9-12.PS3.4

TOPIC: Conduction, Convection, & Radiation -- 3 Day(s)

Description
This topic describes how thermal energy is transferred through different materials by conduction, convection, and radiation.

Academic Vocabulary (What terms will students need to know?)
conduction
convection
radiation
thermal insulator

Learning Targets

I can explain what conduction is and be able to give examples.
SC.9-12.PS3.4

I can explain what convection is and be able to give examples.
SC.9-12.PS3.4

I can explain what radiation is and be able to give examples.
SC.9-12.PS3.4

I can describe the differences between thermal conductors and thermal insulators.
SC.9-12.PS3.4

I can use thermal insulators to control the transfer of thermal energy.
SC.9-12.PS3.4

TOPIC: Electric Charge -- 2 Day(s)

Description
this topic will cover what an electric charge is and how one is created.

Academic Vocabulary (What terms will students need to know?)
static electricity
law of conservation of charge
electric field
conductor
insulator
charging by contact
charging by induction
electroscope

Learning Targets

I can compare gravitational force to electrical force.
SC.9-12.PS3.5

I can differentiate between electrical conductors and insulators.
SC.9-12.PS3.5

I can describe how an object can be electrically charged.
SC.9-12.PS3.5

TOPIC: Electric Current -- 2 Day(s)

Description
This topic covers what an electric current is and how to create one.

Academic Vocabulary (What terms will students need to know?)
electric current
voltage difference
electric circuit
resistance
ohm's law

Learning Targets

I can understand when and how a voltage difference will produce an electric current.
SC.9-12.PS3.5

I can describe how a battery produces a voltage difference while in a circuit.
SC.9-12.PS3.5

I can explain how an electric motor operates.
SC.9-12.PS3.5

TOPIC: Magnetism -- 2 Day(s)

Description
This topic covers how a magnet is surrounded by a magnetic field that exerts a force on magnetic materials.

Academic Vocabulary (What terms will students need to know?)
Magnetism
magnetic field
magnetic pole
magnetic domain

Learning Targets

I can describe how magnetic poles interact.
SC.9-12.PS3.5

I can explain why a magnet exerts a force on distant magnetic materials.
SC.9-12.PS3.5

I can explain why some materials are magnetic and other are not.
SC.9-12.PS3.5

I can show how magnetic domains model magnetic behavior.
SC.9-12.PS3.5

TOPIC: Electricity & Magnetism -- 2 Day(s)

Description
This topic covers how an electric current in a wire is surrounded by a magnetic field

Academic Vocabulary (What terms will students need to know?)
electromagnetic force
electromagnetism
solenoid
electromagnet
galvanometer
electric motor

Learning Targets

I can describe how magnets interact with moving electric charges.
SC.9-12.PS3.5

I can explain how the properties of an electromagnet will affect the strength of its magnetic field.
SC.9-12.PS3.5

I can if necessary refine the investigation plan to produce more accurate, precise, and useful data
SC.9-12.PS3.5

TOPIC: Wave Properties -- 10 Day(s)

Description
This topic will cover include an introduction to waves, their properties, and how they interact with matter.

Learning Targets

I can explain how a generator produces an electric current.
SC.9-12.PS2.5 SC.9-12.PS3.5

I can describe the phenomenon under investigation, which includes the following idea: that an electric current produces a magnetic field and that a changing magnetic field produces an electric current.
SC.9-12.PS2.5

I can develop an investigation plan and describe the data that will be collected and the evidence to be derived from the data about 1) an observable effect of a magnetic field that is uniquely related to the presence of an electric current in the circuit and 2) an electric current in the circuit that is uniquely related to the presence of a changing magnetic field near the circuit. Students describe why these effects seen must be causal and not correlational, citing specific cause-effect relationships.
SC.9-12.PS2.5

I can measure and record electric currents and magnetic fields.
SC.9-12.PS2.5

I can evaluate their investigation, including
o the accuracy and precision of the data collected, as well as limitations of the investigation.
o the ability of the data to provide the evidence required.
SC.9-12.PS2.5

I can if necessary refine the investigation plan to produce more accurate, precise, and useful data such that the measurements or indicators of the presence of an electric current in the circuit and a magnetic field near the circuit can provide the required evidence.
SC.9-12.PS2.5

UNIT: Waves and Their Applications in Technologies for Information Transfer -- 5 Week(s)

Unit Description
This unit will cover wave properties and the use of these properties to convey information through electromagnetic radiation.

TOPIC: Wave Properties -- 10 Day(s)

Description
This topic will cover include an introduction to waves, their properties, and how they interact with matter.

Academic Vocabulary (What terms will students need to know?)
Longitudinal Wave
mechanical wave
medium
transverse wave
wave
amplitude
compression
crest
frequency
period
rarefaction
trough
wavelength
diffraction
interference
node
refraction
resonance
standing wave

Learning Targets

I can explain how waves transfer energy
SC.9-12.PS4.1

I can explain what a mechanical wave is.
SC.9-12.PS4.1

I can differentiate between transverse and longitudinal waves.
SC.9-12.PS4.1

I can identify the parts of a wave.
SC.9-12.PS4.1

I can explain how wavelength and period are related.
SC.9-12.PS4.1

I can describe the relationship between frequency and wavelength.
SC.9-12.PS4.1

I can calculate wave speed.
SC.9-12.PS4.1

I can explain the law of reflection.
SC.9-12.PS4.2

I can explain why waves change directions when they travel from one material to another.
SC.9-12.PS4.2

I can differentiate between refraction and diffraction.
SC.9-12.PS4.2

I can describe what happens when waves interfere with each other.
SC.9-12.PS4.2

TOPIC: Atomic Theory -- 4 Day(s)

Description
This topic will cover what atoms are, their properties, and how to model them.

Learning Targets

I can explain what an electromagnetic wave is.
SC.9-12.PS4.3

I can explain how electromagnetic waves are produced.
SC.9-12.PS4.3

I can identify the properties of electromagnetic waves.
SC.9-12.PS4.3

I can explain how electromagnetic waves transfer energy.
SC.9-12.PS4.3

I can identify the different electromagnetic waves, their properties, and common uses.
SC.9-12.PS4.3

I can explain what a carrier wave is.
SC.9-12.PS4.3

I can identify the effects electromagnetic radiation and why they happen.
SC.9-12.PS4.4

UNIT: Matter and its Interactions -- 6 Week(s)

Unit Description
This unit will describe the structure and properties of matter, the process of chemical reactions, and what happens during a nuclear reaction.

TOPIC: Atomic Theory -- 4 Day(s)

Description
This topic will cover what atoms are, their properties, and how to model them.

Learning Targets

I can recognize the names and symbols of common elements.
SC.9-12.PS1.1

I can create a diagram of the structure of an atom.
SC.9-12.PS1.1

I can explain why the models of an atom have changed over the years and what our current model looks like.
SC.9-12.PS1.1

I can determine the atomic mass and mass number of an atom.
SC.9-12.PS1.1

I can describe the structure of an atom.
SC.9-12.PS1.1

I can identify the number of protons, electrons, and neutrons in a given atom.
SC.9-12.PS1.1

I can identify the differences between substances and mixtures.
SC.9-12.PS1.3

I can identify elements and compounds based on their chemical and physical properties.
SC.9-12.PS1.3

I can identify physical and chemical properties of matter.
SC.9-12.PS1.3

TOPIC: Periodic Table -- 4 Day(s)

Description
This topic will cover how the periodic table is organized, its trends, and how to use it.

Learning Targets

I can explain how the periodic table is organized.
SC.9-12.PS1.2

I can understand the trends of the periodic table and how to apply them.
SC.9-12.PS1.2

I can identify properties of elements based on their location on the periodic table.
SC.9-12.PS1.2

TOPIC: Chemical Bonding -- 4 Day(s)

Description
This topic will cover how/why atoms bond to form compounds and molecules, and the different types of bonds they form.

Learning Targets

I can identify which elements form metallic bonds and why.
SC.9-12.PS1.4

I can identify which atoms form ionic bonds and why.
SC.9-12.PS1.4

I can identify which atoms from covalent bonds and why.
SC.9-12.PS1.4

I can properly write a balanced chemical formula.
SC.9-12.PS1.4

I can use an electron dot diagram to predict chemical bonding.
SC.9-12.PS1.4

I can show why chemical bonding happens through diagrams.
SC.9-12.PS1.4

I can determine the oxidation numbers of given elements.
SC.9-12.PS1.4

I can properly name ionic and covalent compounds.
SC.9-12.PS1.4

TOPIC: Develop a Chemical Reaction Model -- 4 Day(s)

Learning Targets

I can use evidence to develop a model in which they identify and describe the relevant components, including the following:
○ The chemical reaction, the system, and the surroundings under study
o The bonds that are broken during the course of the reaction
o The bonds that are formed during the course of the reaction
o The energy transfer between the systems and their components or the system and surroundings
o The transformation of potential energy from the chemical system interactions to kinetic energy in the surroundings (or vice versa) by molecular collisions
o The relative potential energies of the reactants and the products.
SC.9-12.PS1.5

In the model, I can include and describe the relationships between components, including the following:
o The net change of energy within the system, resulting from bonds that are broken and formed during the reaction
o The energy transfer between system and surroundings by molecular collisions
o The total energy change of the chemical reaction system matched by an equal but opposite change of energy in the surroundings
o The release or absorption of energy, depending on whether the relative potential energies of the reactants and products decrease or increase
SC.9-12.PS1.5

Students use and describe the following chain of reasoning that integrates evidence, facts, and scientific principles to construct the explanation:
o Molecules that collide can break bonds and form new bonds, producing new molecules.
o The probability of bonds breaking in the collision depends on the kinetic energy of the collision being sufficient to break the bond, since bond breaking requires energy.
o Since temperature is a measure of average kinetic energy, a higher temperature means that molecular collisions will, on average, be more likely to break bonds and form new bonds.
o At a fixed concentration, molecules that are moving faster also collide more frequently, so molecules with higher kinetic energy are likely to collide more often.
o A high concentration means that there are more molecules in a given volume and thus more particle collisions per unit of time at the same temperature.
SC.9-12.PS1.5

TOPIC: Chemical Reactions -- 4 Day(s)

Description
This topic will cover the different types of chemical reactions, how to identify them, and how to write a balanced chemical equation

Learning Targets

I can construct an explanation that includes the idea that as the kinetic energy of colliding particles increases and the number of collisions increases, the reaction rate increases.
SC.9-12.PS1.6

I can identify and describe evidence to construct the explanation, including the following:
o Evidence (e.g., from a data table) of a pattern that increases in concentration (e.g., a change in one concentration while the other concentration is held constant) increase the reaction rate, and vice versa
o Evidence of a pattern that increases in temperature usually increase the reaction rate, and vice versa
SC.9-12.PS1.6

Students use and describe the following chain of reasoning that integrates evidence, facts, and scientific principles to construct the explanation:
o Molecules that collide can break bonds and form new bonds, producing new molecules.
o The probability of bonds breaking in the collision depends on the kinetic energy of the collision being sufficient to break the bond, since bond breaking requires energy.
o Since temperature is a measure of average kinetic energy, a higher temperature means that molecular collisions will, on average, be more likely to break bonds and form new bonds.
o At a fixed concentration, molecules that are moving faster also collide more frequently, so molecules with higher kinetic energy are likely to collide more often.
o A high concentration means that there are more molecules in a given volume and thus more particle collisions per unit of time at the same temperature.
SC.9-12.PS1.6

I can identify and describe potential changes in a component of the given chemical reaction system that will increase the amounts of particular species at equilibrium. Students use evidence to describe the relative quantities of a product before and after changes to a given chemical reaction system (e.g., concentration increases, decreases, or stays the same), and will explicitly use Le Chatelier's principle, including the following:
o How, at a molecular level, a stress involving a change to one component of an equilibrium system affects other components
o That changing the concentration of one of the components of the equilibrium system will change the rate of the reaction (forward or backward) in which it is a reactant, until the forward and backward rates are again equal
o A description of a system at equilibrium that includes the idea that both the forward and backward reactions are occurring at the same rate, resulting in a system that appears stable at the macroscopic level
SC.9-12.PS1.7

I can describe the prioritized criteria and constraints, and quantify each when appropriate. Examples of constraints to be considered are cost, energy required to produce a product, hazardous nature and chemical properties of reactants and products, and availability of resources.
SC.9-12.PS1.7

I can systematically evaluate the proposed refinements of the design of the given chemical system. The potential refinements are evaluated by comparing the redesign of the list of criteria (i.e., increased product) and constraints (e.g., energy required, availability of resources).
SC.9-12.PS1.7

I can refine the given designed system by making trade-offs that would optimize the designed system to increase the amount of product and describe the reasoning behind design decisions.
SC.9-12.PS1.7

I can identify and describe the relevant components in the mathematical representations:
o Quantities of reactants and products of a chemical reaction in terms of atoms, moles, and mass
o Molar mass of all components of the reaction
o Use of balanced chemical equation

o Identification of the claim that atoms, and therefore mass, are conserved during a chemical reaction.
o Mathematical representations may include numerical calculations, graphs, or other pictorial depictions of quantitative information

SC.9-12.PS1.8

Given a chemical reaction, I can use the mathematical representations to
o predict the relative number of atoms in the reactants versus the products at the atomic molecular scale.
o calculate the mass of any component of a reaction, given any other component.

SC.9-12.PS1.8

I can describe how the mathematical representations (e.g., stoichiometric calculations to show that the number of atoms or number of moles is unchanged after a chemical reaction where a specific mass of reactant is converted to product) support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

SC.9-12.PS1.8

I can describe how the mass of a substance can be used to determine the number of atoms, molecules, or ions using moles and mole relationships (e.g., macroscopic to atomic molecular scale conversion using the number of moles and !vogadro's number).

SC.9-12.PS1.8

TOPIC: The Sun -- 4 Day(s)

Description
This topic will cover the physical makeup of the sun, its processes, and its importance.

Learning Targets

I can develop models in which they identify and describe the relevant components of the models, including
o identification of an element by the number of protons.
o the number of protons and neutrons in the nucleus before and after the decay.
o the identity of the emitted particles (i.e., alpha, beta—both electrons and positrons, and gamma).
o the scale of energy changes associated with nuclear processes, relative to the scale of energy changes associated with chemical processes.
SC.9-12.PS1.9

I can develop five distinct models to illustrate the relationships between components underlying the nuclear processes of 1) fission, 2) fusion, and 3) three distinct types of radioactive decay
SC.9-12.PS1.9

I can include the following features, based on evidence, in all five models:
o The total number of neutrons plus protons is the same both before and after the nuclear process, although the total number of protons and the total number of neutrons may be different before and after.
o The scale of energy changes in a nuclear process is much larger (hundreds of thousands or even millions of times larger) than the scale of energy changes in a chemical process
SC.9-12.PS1.9

I can develop a fusion model that illustrates a process in which two nuclei merge to form a single, larger nucleus with a larger number of protons than were in either of the two original nuclei.
SC.9-12.PS1.9

I can develop a fission model that illustrates a process in which a nucleus splits into two or more fragments that each have a smaller number of protons than were in the original nucleus.
SC.9-12.PS1.9

In both the fission and fusion models, I can illustrate that these processes may release energy and may require initial energy for the reaction to take place.
SC.9-12.PS1.9

I can develop radioactive decay models that illustrate the differences in type of energy (e.g., kinetic energy, electromagnetic radiation) and type of particle (e.g., alpha particle, beta particle) released during alpha, beta, and gamma radioactive decay, and any change from one element to another that can occur due to the process.
SC.9-12.PS1.9

I can develop radioactive decay models that describe that alpha particle emission is a type of fission reaction, and that beta emission and gamma emission are not.
SC.9-12.PS1.9

UNIT: Earth's Place in the Universe -- 6 Week(s)

Unit Description
This unit will cover the history of planet earth, its place in the solar system and the universe and its stars.

Enduring Understandings/Essential Learner Outcomes
I can identify evidence that suggest Earth's continents have moved.
I can explain how evidence of ancient climates supports continental drift.
I can identify evidence that the sea floor is spreading and explain the process.
I can explain how the plate tectonics create geological features.
I can identify the three types of plate boundaries and features associated with them.

I can explain how the solar system formed.
I can recognize early concepts of the structure of the solar system and how it has changed over time.

I can describe how our current knowledge of the solar system was developed
I can explain the relationship between gravity and the motions of the objects in the solar system.

TOPIC: The Sun -- 4 Day(s)

Description
This topic will cover the physical makeup of the sun, its processes, and its importance.

Learning Targets

I can identify and describe the layers and features of the sun.
SC.9-12.ESS1.1

I can explain the process of energy production in the Sun
SC.9-12.ESS1.1

I can define the three types of spectra.
SC.9-12.ESS1.1

TOPIC: The Big Bang -- 4 Day(s)

Description
This topic will cover what the big bang theory is, evidence that supports it, and how it created our solar system.

Learning Targets

I can explain how the solar system formed.
SC.9-12.ESS1.2

I can explain how early concepts of our solar system were developed.
SC.9-12.ESS1.2

I can explain how our current knowledge of our solar system developed.
SC.9-12.ESS1.2

I can explain the Big Bang theory through evidence gathered from our universe.
SC.9-12.ESS1.2

TOPIC: Stellar Evolution -- 4 Day(s)

Description
This topic will cover the life cycle of stars and how the internal processes change with the age of the star.

Learning Targets

I can explain the relationship between mass and a star's evolution.
SC.9-12.ESS1.3

I can explain the features of massive and regular star life cycles.
SC.9-12.ESS1.3

I can explain how the universe is affected by the cycles of stars.
SC.9-12.ESS1.3

TOPIC: The Solar System -- 4 Day(s)

Description
This topic will cover Kepler's Law and how it regulates all objects in our solar system.

Learning Targets

I can explain the relationship between gravity and the motions of the objects in the solar system.
SC.9-12.ESS1.4

I can explain and use Kepler's laws
SC.9-12.ESS1.4

I can identify the characteristics of the inner planets
SC.9-12.ESS1.4

I can identify the characteristics of the outer plants.
SC.9-12.ESS1.4

I can use evidence to develop a model in which I identify and describe Earth's physical features and processes.
SC.9-12.ESS1.4

TOPIC: Plate Tectonics -- 4 Day(s)

Description
In this topic the student will evaluate evidence of the past and current movements of continental and oceanic crust, the theory of plate tectonics, and relative densities of oceanic and continental rocks to explain why continental rocks are generally much older than rocks of the ocean floor.

Learning Targets

I can identify past and current movements of continental and oceanic crust.
SC.9-12.ESS1.5

I can explain the theory of plate tectontics.
SC.9-12.ESS1.5

I can explain why continental rocks are generally older than ocean floor rocks based on their densities.
SC.9-12.ESS1.5

TOPIC: Earth's History -- 4 Day(s)

Description
In this topic the student will apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth’s formation and early history

Learning Targets

I can show evidence that the earth is 4.6 billion years old.
SC.9-12.ESS1.6

I can identify early earth's heat sources.
SC.9-12.ESS1.6

I can explain how Earth went through the process of differentiation.
SC.9-12.ESS1.6

I can explain how the earth's crust and continents formed.
SC.9-12.ESS1.6

I can explain how earth's atmosphere and oceans formed.
SC.9-12.ESS1.6

I can differentiate between the paleozoic, mesozoic, and cenozoic eras.
SC.9-12.ESS1.6

TOPIC: Engineering Problems -- 3 Week(s)

Description
In this topic the student will learn to analyze a major global problem and break it down into smaller more manageable problems that can be solved using engineering.

Learning Targets

I can use evidence to develop a model in which I identify and describe Earth's physical features and processes.
SC.9-12.ESS2.1

In the model, I can describe the relationships between components, including specific internal processes, mainly volcanism, mountain building, or tectonic uplift, specific surface processes, mainly weathering and erosion, interactions between processes, and the rate at which the features change.
SC.9-12.ESS2.1

I can use the model to illustrate the relationship between 1) the formation of continental and ocean floor features and 2) Earth’s internal and surface processes operating on different temporal or spatial scales.
SC.9-12.ESS2.1

I can organize data that represent measurements of changes in hydrosphere, cryosphere, atmosphere, biosphere, or geosphere in response to a change in Earth’s surface.
SC.9-12.ESS2.2

I can use tools, technologies, and/or models to analyze the data and identify and describe relationships in the data sets
SC.9-12.ESS2.2

I can analyze data to identify effects of human activity and specific technologies on Earth’s systems if present.
SC.9-12.ESS2.2

I can use the analyzed data to describe a mechanism for the feedback between two of Earth’s systems and whether the feedback is positive or negative, increasing (destabilizing) or decreasing (stabilizing) the original changes
SC.9-12.ESS2.2

I can use the analyzed data to describe a particular unanticipated or unintended effect of a selected technology on Earth’s systems if present
SC.9-12.ESS2.2

I can develop a model (i.e., graphical, verbal, or mathematical) in which they identify and describe the components based on both seismic and magnetic evidence (e.g., the pattern of the geothermal gradient or heat flow measurements) from Earth’s interior
SC.9-12.ESS2.3

I can describe the relationships between components in the Earth's internal model
SC.9-12.ESS2.3

I can use the model to describe the cycling of matter by thermal convection in Earth’s interior.
SC.9-12.ESS2.3

UNIT: Engineering, Technology, and Application of Science -- 6 Week(s)

Unit Description
In this unit the student will learn to recognise real-world problems that can be solved through engineering and how to properly develop a solution to the problem.

TOPIC: Engineering Problems -- 3 Week(s)

Description
In this topic the student will learn to analyze a major global problem and break it down into smaller more manageable problems that can be solved using engineering.

Learning Targets

I can describe the challenge with a rationale for why it is a major global challenge.
SC.9-12.ETS.1

I can describe qualitatively and quantitatively, the extent and depth of the problem and its major consequences to society and/or the natural world on both global and local scales if it remains unsolved.
SC.9-12.ETS.1

I can document background research on the problem from two or more sources, including research journals.
SC.9-12.ETS.1

In my analysis, I can identify the physical system in which the problem is embedded, including the major elements and relationships in the system and boundaries so as to clarify what is and is not part of the problem.
SC.9-12.ETS.1

In my analysis, I can describe societal needs and wants that are relative to the problem (e.g., for controlling CO2 emissions, societal needs include the need for cheap energy).
SC.9-12.ETS.1

I can specify qualitative and quantitative criteria and limitations (constraints) for acceptable solutions to the problem.
SC.9-12.ETS.1

I can restate the original complex problem into a set of two or more subproblems (possibilities include in writing or as a diagram or flow chart).
SC.9-12.ETS.2

For each of the subproblems, I can propose at least one solution that is based on student-generated data and/or scientific information from other sources.
SC.9-12.ETS.2

For each of the subproblems, I can propose at least one solution that is based on student-generated data and/or scientific information from other sources.
SC.9-12.ETS.2

I can describe how solutions to the subproblems are interconnected to solve all or part of the larger problem.
SC.9-12.ETS.2

I can describe the criteria and limitations (constraints) for the selected subproblem.
SC.9-12.ETS.2

I can describe the rationale for the sequence of how subproblems are to be solved and which criteria should be given highest priority if trade-offs must be made.
SC.9-12.ETS.2

TOPIC: Developing Possible Solutions -- 3 Week(s)

Description
In this topic the student will learn to evaluate a solution to a real-world problem based on certain criteria and trade-offs that account for different variables.

Learning Targets

I can provide an evidence-based decision of which solution is optimum, based on prioritized criteria, analysis of the strengths and weaknesses of each solution, and barriers to be overcome.
SC.9-12.ETS.4

In my evaluation, I can describe which parts of the complex real-world problem may remain even if the proposed solution is implemented.
SC.9-12.ETS.4

I can identify the complex real-world problem, with numerous criteria and limitations (constraints).
o Identify the system that is being modeled by the computational simulation, including the boundaries and individual components of the systems.
o Identify what variables can be changed by the user to evaluate the proposed solutions, trade-offs, or other decisions.
o Identify the scientific principles and or relationships being used by the model.
SC.9-12.ETS3.3

I can use the given computer simulation to model the proposed solutions by selecting logical and realistic inputs and using the model to simulate the effects of different solutions, trade-offs, or other decisions.
SC.9-12.ETS3.3

I can analyze the simulated results as compared to the expected results.
SC.9-12.ETS3.3

I can interpret the results of the simulation and predict the effects of the proposed solutions within and between systems relevant to the problem based on the interpretation.
SC.9-12.ETS3.3

I can identify the possible negative consequences of solutions that outweigh their benefits.
SC.9-12.ETS3.3

I can identify the simulation’s limitations (constraints).
SC.9-12.ETS3.3