SACRAMENTO CITY UNIFIED SCHOOL DISTRICT
BOARD OF EDUCATION

Agenda Item# 11.1o

Meeting Date: August 20, 2020

Subject: Approve Adoption of New Courses of Study

- ☐ Information Item Only
- ☒ Approval on Consent Agenda
- ☐ Conference (for discussion only)
- ☐ Conference/First Reading (Action Anticipated: _____)
- ☐ Conference/Action
- ☐ Action
- ☐ Public Hearing

Division: Academic Office / Curriculum and Instruction

Recommendation: The Board of Education adopts the following courses of Study:

- Physics of the Universe (Physics with Earth Science)
- Biology: The Living Earth (Biology with Earth Science)
- Chemistry in the Earth System (Chemistry with Earth Science)
- Molecular Biology: The Living Earth (Biology with Earth Science)
- Honors Chemistry in the Earth System
- ELD Physics in the Universe
- ELD Biology: The Living Earth
- ELD Chemistry in the Earth System
- ELD American Government
- ELD Modern Economics
- Latin IV

Background/Rationale:
In June 2019 the Board of Education adopted a science pathway at High School which integrates Earth Science into Biology, Physics and Chemistry courses. In March 2020, the Board of Education adopted new instructional materials for science which are aligned to the Next Generation Science Standards (NGSS). The district has now developed new courses of study which are aligned to the NGSS and to the integrated pathway. These courses have all recently been approved in the Laboratory Science (d) category by UC/CSU. These courses will be available to all high schools, with the exception of Honors Chemistry, which is available at West Campus and CK McClatchy and Molecular Biology which will be available at John F Kennedy and CK McClatchy.

The new English Language Development (ELD) courses will provide access to core content within the English Learner newcomer pathway (English Learner: overall ELPAC score of 1 or 2 and enrolled in U.S. schools for fewer than three years). These courses will fulfill students A-G and graduation requirements within Sacramento City Unified School District while supporting English Language Development. The ELD science

courses have all recently been approved in the Laboratory Science (d) category by UC/CSU. The ELD Social Science courses have recently been approved in the History / Social Science (a) category by UC/CSU. These ELD courses will be available to all high schools.

Latin IV is a language class to be used at Kennedy High School. It has recently been approved in the Language Other than English (E) category by UC/CSU.

Financial Considerations: N/A

LCAP Goal(s): College, Career and Life Ready Students

Documents Attached:

Courses of Study for:

- Physics of the Universe (Physics with Earth Science)
- Biology: The Living Earth (Biology with Earth Science)
- Chemistry in the Earth System (Chemistry with Earth Science)
- Molecular Biology: The Living Earth (Biology with Earth Science)
- Honors Chemistry in the Earth System
- ELD Physics in the Universe
- ELD Biology: The Living Earth
- ELD Chemistry in the Earth System
- ELD American Government
- ELD Modern Economics
- Latin IV

Estimated Time of Presentation: N/A
Submitted by: Christine Baeta, Chief Academic Officer and
Matt Turkie, Assistant Superintendent of Curriculum and Instruction
Approved by: Jorge A. Aguilar, Superintendent

Sacramento City Unified School District

COURSE OF STUDY

FOR

Physics of the Universe (Physics w/ Earth Science)
QPS260, QPS261

Segment	High School
Length of Course	One Year
Developed by	*SCUSD Teacher Committee* *Aaron Pecho, Science Coordinator* *Janna Cantwell, Training Specialist*
First Edition	*Fall 2020*

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

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HS Physics of the Universe

SECTION ONE — GENERAL INFORMATION

COURSE DESCRIPTION

(Physics in the Universe is a college preparatory laboratory and math-based science class that will prepare students in grades 9-12 to be successful in college level lab science courses. The course integrates earth science into Physics as a first year course. It is aimed at building a solid foundation in physical science, integrating an intensive laboratory component that consists of both classroom labs and practical field studies, and building student competency in science practices and cross cutting concepts. This course devotes at least 40 percent of the class time to student-centered laboratory activities and will emphasize the process of inquiry and critical thinking. Throughout this course students will progressively grow in their physics knowledge and use this collective understanding to explore and design an efficient means of producing renewable energy.)

RATIONALE

The Universe operates on the interaction of matter and the four fundamental forces, gravity, electromagnetism, the nuclear strong force and the nuclear weak force. An understanding of the relationships between matter and these forces can explain much of what happens in the world around us. Physics can explain what drives "Climate Change" and how humanity affects it. At the student level, Physics can contribute to an understanding of Chemistry, Biology and Earth Science. It can inform our students in how the objects and systems in their household work, enabling home repairs and contributing to the sense of self-sufficiency for our students. In the end, Physics can bring home the consequences of safe and unsafe behaviors that will help our students lead vibrant and successful lives.

COURSE GOALS

Upon completion of this course, students will be able to:

- *Use Physics to help interpret events or occurrences in the natural environment of the student.*
- *Think using the ways in which a scientist solves problems.*
- *Become a better informed member of society.*

COURSE STANDARDS

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system
HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay
HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration
HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system
HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision
HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects
HS-PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current
HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials *
HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known
HS-PS3-2. Develop and use 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 position of particles (objects)
HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy *
HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction
HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media
HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information
HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other [
HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter
HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy *
HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks

HS-ESS1-6. 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
HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features
HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios *
HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity
HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants
HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts
HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem *The performance expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea

INSTRUCTIONAL MATERIALS

(Accelerate Learning- STEMscopes)

SUPPLEMENTARY MATERIALS:

(if available)

SUGGESTED AVERAGE TIME FOR COVERING MAJOR UNITS

Segment 1: Forces and Motion - **4 weeks**
Segment 2: Forces at a Distance - **4 weeks**
Segment 3: Energy Conversion and Renewable Energy - **5 weeks**
Segment 4: Nuclear Processes and Earth's History - **6 weeks**
Segment 5: Waves and Electromagnetic Radiation - **7 weeks**
Segment 6: Stars and the Origins of the Universe - **8 weeks**

TEACHER RESOURCES

(Accelerate Learning- STEMscopes)

https://phet.colorado.edu/
https://www.ck12.org/teacher/
https://www.aapt.org/
http://ncnaapt.org/
https://www.physicsclassroom.com/

RECOMMENDED STUDENT RESOURCES

Accelerate Learning- STEMscopes

https://www.khanacademy.org/
http://hyperphysics.phy-astr.gsu.edu/hbase/index.html
CrashCourse

SECTION TWO — COURSE UNITS

Segment 1: Forces and Motion

Newton's Laws provide a basis of understanding forces and motion, and therefore, serve as a foundation for a study of physics. Students will need to collaboratively construct a device in order to address an engineering design challenge built on the background of Newton's Laws and momentum. In order to meet this challenge, students will develop models of the challenge, and design and revise their design based on data and their knowledge of physics. Students will begin by investigating collisions, and by dissecting a collision and describing the motion of objects. They will do this by developing models of motion and forces, conducting experiments, gathering data, and revising their models. To support this learning, students will interpret tables and graphs of position and velocity as a function of time for objects subjected to a constant, net unbalanced force and compare their observations to predictions from mathematical models. Students will develop models of motion of falling objects, and gather data to improve their models, and explain the concept of acceleration due to the gravitational force by means of data analysis. Students will use data to prove that technological advancements such as airbags and crumple zones reduce the force of an impact by analyzing videos of collisions and by measuring impact time and impact forces for different collisions. Students will apply their knowledge in order to complete the engineering design challenge.

Segment Guiding Questions:

- How can Newton's Laws be used to explain how and why things move?
- How can mathematical models of Newton's Laws be used to test and improve engineering designs?
- How can you minimize the force on a macroscopic object during a collision?

Standards Addressed

HS-PS2-1- Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

HS-PS2-2- Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

HS-PS2-3- Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

HS-ETS1-1- Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2- Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3- Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4- Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Instructional Objectives

Students will be answer the following questions:

Scope	Driving Questions
Newton's 2nd Law of Motion	● According to Newton's 2nd Law of motion, what relationship exists between mass and acceleration if force is constant? ● Why can we say that the ratio of net force to mass is constant for any dropped object? ● What causes an object to accelerate?
Momentum	● How does an object's mass and velocity relate to its momentum? ● How can the conservation of momentum during an inelastic collision be described by a mathematical model? ● When designing a device to minimize the impact force, why would the materials and mass of the device be important?

Suggested Activities

Scope	Activity
Newton's 2nd Law	Explore 1: Does Mass Matter? *Students will demonstrate how mass impacts the acceleration of an object and write a CER based on Newton's second law and the relationship of mass and acceleration when force is held constant.* Explore 2: Acceleration Due to Gravity Lab *Students perform an investigation to calculate the acceleration due to gravity of a falling object in order to determine if it stays constant.* Explore 3 - Which Car Is The Fastest?

	Two car manufacturers are claiming their cars are the fastest. In this activity, students will receive a data table that includes each car's make and model, its horsepower, the force of its engine, and the time each car takes to travel a given distance. Students need to prove which manufacturer has the fastest car, using the concepts of Newton's second law.
Momentum	Explore 1: Cart Bowling *Students will design and conduct an investigation to show the relationship of mass, velocity, and momentum, using carts and different masses.* Explore 2: Conservation of Momentum *Students will investigate conservation of momentum, using an inelastic collision with a ball and a stationary cup.* Explore 3 - Eggonaut Spacecraft Design *The students will use their knowledge of momentum and impulse to create a device to lessen impact force.*

Suggested Assessment:

Students will create an infographic to inform consumers of three different safety features in vehicles. They will research ways to increase car safety and develop their own idea that will add to car safety. They will then create a proposal to send back to the car manufacturer along with their infographic.

Segment 2: Forces at a Distance

The foundation of forces and motion are used to predict and explain gravitational and electromagnetic interactions that occur at a distance. Students investigate gravitational and electromagnetic forces through a series of small experiments and describe them conceptually and mathematically. They predict the motion of orbiting objects in the solar system. They link the macroscopic properties of materials to microscopic electromagnetic attractions (charge, Coulomb's law). Students will use mathematical models to explore Newton's Law of Gravitation to describe and predict the gravitational attraction between two objects, then compare the Law of Gravitation to Coulomb's Law to conclude that gravitational and electrostatic forces share a common geometry, radiating out as spherical shapes from their point of origin.

Standards Addressed

HS-PS2-4 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

Instructional Objectives

Students will be able to answer the following questions:

Scope	Driving Questions
Kepler's Laws	● Do all celestial objects follow an orbit similar to Earth's? ● How are models useful in understanding Kepler's first law of planetary motion, the law of ellipses? ● How does Kepler's second law of planetary motion, the law of equal areas, relate a planet's distance to the sun and its orbital velocity? ● If the gravitational force of the Sun were to change, would Kepler's third law of planetary motion, the law of harmonies, still be valid?
Gravitational and Electrostatics Forces	● What underlying forces explain the relationship between the Sun and the Planets orbiting around the Sun? ● What is the relationship among gravitational force, mass, and the distance between two objects, as described by Newton's law of gravitation? ● How can electrostatic forces be used to lift objects? ● How is electrostatic force impacted by charge and distance?

Students investigate gravitational and electromagnetic forces and describe them mathematically. These forces predict the motion of orbiting objects in the solar system and link the macroscopic properties of materials to microscopic electromagnetic attractions.

Guiding Questions:
- How can different objects interact when they are not even touching?
- How do interactions between matter at the microscopic scale affect the macroscopic properties of matter that we observe?
- How do satellites stay in orbit?

Suggested Activities

Scope	Activity
Kepler's Laws	Explore 1: The Big E *Students will create different ellipses to simulate planetary orbits and discover the mathematical relationships that led Kepler to formulate his first law of planetary motion. Students will use solar system-object data to calculate eccentricities of the objects for comparison and then write a scientific explanation for why average distance is used for planets.* Explore 2: Celestial Sweep *Students will explore an interactive website on Kepler's second law of planetary motion and simulate different planet orbits to discover that planets sweep out equal areas in equal time and why planets closer in orbit to the Sun move faster than when they are further away.* Explore 3: Spinning Stopper and NASA NASCAR *In Part I, students will investigate how shortening the spinning length (orbital radius) of a washer affects its speed and how this relates to the period of revolution and orbital velocity of planets around the Sun. Also, students will consider how the mass of the Sun and planets affects their orbit. In Part II, students will compare a NASCAR race with planetary orbits, and in Part III they will calculate the relationship between orbital period and orbital radius for several planets.*
Gravitational and Electrostatic Forces	Explore 1: Newton's Law of Universal Gravitation *In this activity, students will use a PhET simulation to discover the relationship between gravitational force, mass, and the distance between two objects.* Explore 2: Electrostatic Lifting *Based on Coulomb's law on electric forces, students will investigate how the force of an electric charge and the distance between objects are mathematically related and what happens to force when distance changes. Students would find the right combination of electrostatic materials that generates the most lifting force, graph the lifting heights compared to paper weight, and analyze the results.* Explore 3: A Roll of the Dice *In this activity, students will practice calculating the force between two charged particles.*

- Students will develop a visual model to better understand what is happening within charged materials, and then use this as a basis for better understanding the physics of electric charges. They will also demonstrate and explain the process of charge polarization.
- Students will construct a simple DC motor.

Summary of Sample Assignment: Students will construct a model for satellite motion by analyzing data from PHeT Gravity and Orbits simulation. The changes of mass and distance are modeled and applied to the Universal Gravitation equation.

Unit Lab Activities-

Students will create different ellipses to simulate planetary orbits and discover the mathematical relationships that led Kepler to formulate his first law of planetary motion. Students will use solar system-object data to calculate eccentricities of the objects for comparison and then write a scientific explanation for why average distance is used for planets. Students will use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another.

Suggested Assessment

Claim- Evidence- Reasoning

Scenario

Imagine that NASA has identified an object on a possible collision course with Earth. NASA will need to brief the president of the United States about the orbital path and whether the object could impact Earth or its satellites. Calculate the eccentricity and orbital period in the following tables:

Prompt

Write a scientific explanation that justifies your prediction of the possible impact of the object with Earth or a satellite.

Segment 3: Energy Conversion and Renewable Energy

Students will differentiate between kinetic, potential, and thermal energy and be able to calculate the change in the energy of a system from one form to another showing that energy is conserved. Students investigate different methods of energy production and energy transfer. During this unit students will track energy transfer and conversion through different stages of commercial and residential power sources. They will also evaluate different power source technologies. This may include investigations with

electromagnetism and solar photovoltaic systems to create models of how power generation works. They also may include the design and testing of their own energy conversion devices.

Segment Guiding Questions

- How do power plants generate electricity?
- What engineering designs can help increase the efficiency of our electricity production and reduce the negative impacts of using fossil fuels?

Standards Addressed

HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

HS-PS3-2 Develop and use 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 position of particles(objects).

HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

HS-PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Instructional Objectives

Students will be able to answer the following questions:

Scope	Driving Questions
Interaction of Forces	● How do the current, the number of wire loops, and the core create or influence the magnetic field of an electromagnet? ● How can a magnetic field cause electrons to move in a wire?
Energy and Its Applications	● How can the law of conservation of energy be used to calculate the change in energy of one form in a system? ● How do power plants use different energy transformations? ● How do energy transformation prove the law of conservation of energy?
Resources and Sustainability	● What role can conservation, recycling, and reuse of resources play in their management? ● How are resource management, the sustainability of human populations, and ecosystem biodiversity dependent on each other?

Suggested Activities:

Scope	Activity
Interaction of Forces	Explore 1: Scientific Investigation - Creating an Electromagnet

	Students will conduct an investigation that allows them to test and determine the factors affecting the magnetic-field strength of an electromagnet. Explore 2: Activity - Electromagnetic Induction Students will use an online simulation to observe how changing magnetic fields can produce an electric current. Then, they will draw two diagrams, one that shows how electric currents produce magnetic fields and another that shows how changing magnetic fields produces electric current.
Energy and Its Applications	Explore 1: Scientific Investigation - Energy - Let's Play! Students investigate different types of energies using toys, then calculate the changes in the types of energy of the toy car. Students will then complete a CER regarding conservation of energy. Explore 2: Scientific Investigation - Where does Energy Come From? Students will experience different types of energy and energy conversions using a hand-crank flashlight. Explore 3: Activity - Where Does the Power Come From? Students will discuss the types of energies that go into and come out of different types of power plants. Explore 4: Research - How Do Power Plants Work? Students are researching how different types of power plants generate electricity.
Resources and Sustainability	Explore 1: Research - Mining Earth's Resources This is a three-part assignment that allows students to research and present how different resources are mined and how resource collection impacts the economy, society, environment and geopolitics. Two groups will then compare and decide what resource is more beneficial based on costs and benefits and create a brochure to present that information. Lastly, students will complete a CER on which one energy process would be most beneficial for a company to go green. Explore 2: Engineering Solution - Eco-Friendly Builders

	Students will design a structure to illustrate the relationships between the management of natural resources, sustainability of human populations, and biodiversity.

Suggested Assessment

Students will use solar panels with a motor to design an apparatus that demonstrates the transformation of solar energy to mechanical energy by attempting to elevate loads of various masses. Through usage of technology such as websites, presentations, or other modern media, students must demonstrate their understanding of energy, conservation of energy, and efficiency both qualitatively as well as quantitatively.

Segment 4: Nuclear Processes and Earth History

Students develop a model of the internal structure of atoms and then extend it to include the processes of fission, fusion, and radioactive decay. They apply this model to understanding nuclear power and radiometric dating. They use evidence from rock ages to reconstruct the history of the Earth and processes that shape its surface.

Sample Guiding Questions:

- How do nuclear reactions illustrate conservation of energy and mass?
- Why are some materials dangerous, emitting harmful radiation?
- How do we determine the age of rocks and other geologic features?
- How can we determine the age of the earth?

Standards Addressed

HS-PS1-8 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

HS-ESS1-6 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.

HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

Instructional Objectives

Students will be able to:

Students develop a model of the internal structure of atoms and then extend it to include the processes of fission, fusion, and radioactive decay. They apply this model to understanding nuclear power and radiometric dating. They use evidence from rock ages to reconstruct the history of the Earth and processes that shape its surface. Students apply their knowledge to create a proposal to an independent space contractor for a mission to the Jovian moon Europa.

Scope	Driving Questions
Nuclear Processes	● How does the radioactive decay of elements help determine the age of rocks? ● How does the composition of an atom's nucleus and the type of energy released compare between the types of radioactive decay? ● How do the total number of protons and neutrons before and after the reaction compare for a fission reaction and a fusion reaction?
Plate Tectonics	● What properties and processes drive the movement of plates on Earth's surface? ● How do the different types of plate motion along boundaries create different surface features? ● What processes create and change surface features at plate boundaries? ● Why is it possible to use hotspots to calculate tectonic plate speed?
Earth's Early History	● How does the solar nebula theory explain the formation of Earth's solar system? ● Why do scientists have to use evidence from meteorites, lunar rocks, and observations of the solar system to understand Earth's formation and age?

Guiding Questions

- What does E=mc2 mean?

- How do nuclear reactions illustrate conservation of energy and mass?
- How do we determine the age of rocks and other geologic features?

Suggested Activities:

Scope	Activity
Nuclear Processes	Explore 1: Scientific Investigation - Radioactive decay Students will model the half-life of the element carbon-14 to simulate the radioactive decay in Earth's interior that is a major source of Earth's heat. Students will use the information from this activity to complete a CER about the age of oceanic and continental crust. Explore 2: Activity - Uranium 238 In this activity, students are given information about the three types of radiation. The information given will be used to identify characteristic properties of each. Students will also create a radioactive-decay series involving alpha and beta decay, first by using a grid, and then by identifying the nuclear equations for each transition. Finally, students will graphically represent the radioactive decay of uranium-238. Explore 3: Activity - Fission vs. Fusion In this activity, students will model a fusion and fission reaction in two short activities, then they will analyze the differences and similarities between the two types of nuclear reactions.
Plate Tectonics	Explore 1: Scientific Investigation - The Shell of the Earth Students will use a hard-boiled egg to illustrate and reference the three layers of Earth: the core, the mantle, and the crust. Students will attempt to separate the eggshell into different plates,modeling the major and minor plates the crust is divided into. Students will conclude by attempting to reassemble the plates of another group onto their egg, illustrating fundamental ideas behind the theory of plate tectonics. Explore 2: Activity - Edible Plate Boundaries Students will model the three different plate boundaries, using graham crackers and icing to

	illustrate what occurs when lithospheric plates interact. As they do so, they will investigate different phenomena that occur at each plate boundary as well as what land structures are formed there. Explore 3: Activity - Landforms at Plate Boundaries Students will be working together in groups of three in order to illustrate the land features and ocean-floor features at a randomly assigned plate boundary. Students will use this model to describe how long it took to create these features and what the causal agents were to their creation. Explore 4: Activity - Hotspot Volcanoes Students determine how fast tectonic plates move based on hot spot volcanism by using maps of the Hawaiian Islands, Galápagos Islands, and Yellowstone Caldera. Students measure the distance between the volcanos on each map and calculate the ages of the tectonic plates to determine the speed the plates were moving between each volcano. Finally, students determine the average speed for each plate.
Earth's Early History	Explore 1: Research - Putting the Pieces Together Students will be working within expert groups to research one topic within the solar nebula theory. Students will present their research to the class and obtain data on topics that they did not research as they listen to other presentations. They will be regrouped and use this collected data to create a complete account of how Earth and the solar system were formed and create a timeline of events. Explore 2: Inquiry Investigation - Comparing Craters Students will perform a scientific investigation to show how weathering and erosion have changed the surface evidence of the heavy bombardment period.

- Students will use a model to explain the changes in the makeup of the nucleus of an atom and explain the release of the energy. Groups pick fission, fusion, alpha, beta, gamma – explain model to class.
- Students will develop models of seafloor spreading.

- **Summary of Sample Assignment:** Students will draw a visual model of how convection currents work in the core of the earth. In order for students to draw this model the students will fill a transparent, rectangular tub with water. Two hot cups of water are placed underneath the two ends of the tub and one cold cup of water is placed underneath the middle of the tub. A few drops of red dye are placed inside the tub just above the hot cups and a few drops of blue dye are placed inside the tub just above the cold cup. Students will then observe the convection currents. After drawing their models the students will make claims on how they think convection currents impact the theory of plate tectonics.

Unit Lab Activities-

Students will be working within expert groups to research one topic within the solar nebula theory. Students will present their research to the class and obtain data on topics that they did not research as they listen to other presentations. They will be regrouped and use this collected data to create a complete account of how Earth and the solar system were formed and create a timeline of events.

Suggested Assessment

Claim-Evidence- Reasoning

Scenario

"Scientists on a diving expedition collected a set of rock samples from the shore of the continent to a divergent (or convergent) plate boundary 100 m offshore." Scientists on a diving expedition collected rock samples at a plate boundary 10 km offshore between the ocean and a continent. Upon analysis of the rock collection, the rocks were found to be of differing ages. How can the rock be of different ages? How can this be possible if the rocks all came from the same collection area?

Prompt

Write a scientific explanation that justifies why continental and oceanic rocks are different ages. Make sure to include a rebuttal in your answer.

Segment 5: Waves and Electromagnetic Radiation

Students make mathematical models of waves and apply them to seismic waves traveling through the Earth. They obtain and communicate information about other interactions between waves and matter with a particular focus on electromagnetic waves. They obtain, evaluate, and communicate information about health hazards associated with electromagnetic waves. They use models of wave behavior to explain information transfer using waves and the wave-particle duality. Students look at data sets from various satellites and telescopes to demonstrate how knowledge of electromagnetic radiation helps humans to understand their surroundings, whether it be

weather patterns on Earth, the temperature of the Earth, the ages of stars in distant galaxies, or the atmospheric composition of planets in our solar system and beyond.

Segment Guiding Questions:

- How do we know what is inside the Earth?
- Why do people get sunburned by UV light?
- How can we transmit information over wires and wirelessly?
- How is music created and transmitted?

Standards Addressed

HS-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

HS-PS4-2 Evaluate questions about the advantages of using a digital transmission and storage of information.

HS-PS4-3 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

HS-PS4-4 Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

HS-PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

Instructional Objectives

Students will be able to answer the following questions:

Scope	Driving Questions
Waves, Matter and the Earth	● What is the relationship between the wavelength, frequency, and the velocity of a wave?

	● How can the medium a wave is traveling through affect its behavior? ● How can you evaluate the validity and reliability of claims about the effects of radiation on matter? ● How are P-waves and S-waves different? ● How are seismic waves used to investigate the Earth's interior?
Wave Models	● What evidence supports the idea that electromagnetic radiation behaves like a wave? ● Why are there two models for the behavior of light: the wave model and the particle model? ● How does the photoelectric effect support the idea that light behaves like a particle?
Waves used in Technology	● How can the behaviors of waves and their interaction with matter be used in technology? ● What is photoelectric effect, and how is it useful to society through technology? ● What are the advantages and disadvantages of digital transmission and data storage?

Suggested Activities

Scope	Activity
Waves, Matter and the Earth	<u>Explore 1: Wave Relationships</u> Students will use long slinkys to observe wave pulses, wave interference, transverse waves, longitudinal waves, wave speed, and standing waves. <u>Explore 2: Waves in Different Media</u> Students will observe wave properties of transverse and longitudinal waves in different media. <u>Explore 3 - Concern for Cell Phones</u> Students understand that photons associated with different frequencies of electromagnetic waves have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation <u>Explore 4: Slinky Seismology</u> Students will use a slinky to model the structure and function of seismic waves (S-waves and P-waves) to visualize how they can be used to investigate the layers of Earth.

	Explore 5: What Can a Wave Really Tell Us? Students will research past natural disasters, work with materials to understand stress and faulting, test ocean waves vs tsunami wave properties, learn about seismic waves, how they affect us, test seismic engineering solutions, and learn about and test mitigation efforts for tsunamis.
Wave Models	Explore 1: Does Light Behave Like Waves? Students observe effects such as resonance, interference, diffraction, and photoelectric effect. Explore 2: Blackbody Radiation Students do a worksheet on the blackbody radiation by reading, discussing, and writing a worksheet and taking a summative exam. Explore 3 - The Photoelectric Effect Students do a worksheet on the photoelectric effect by reading, discussing, and writing a worksheet and taking a summative exam.
Waves used in Technology	Explore 1: Uses of Waves Students will locate the epicenter of an earthquake by using the graph of the S and P wave traveling time difference vs. distance from the epicenter. Students then use a compass to draw three circles with the distances of the three cities to the epicenter. Then, the intersection point of these three circles is the epicenter. Explore 2: Waves in Technology Students understand that the photovoltaic (solar) cells capture light and convert it to electricity; medical imaging (magnetic resonance imaging (MRI) and X-rays); and communications technology. Explore 3 - The Bookless Library Students explore the bookless library by searching the internet for information.

Students make mathematical models of waves and apply them to seismic waves traveling through Earth. They obtain and communicate information about other interactions between waves and matter with a particular focus on electromagnetic waves, and they obtain, evaluate, and communicate information about health hazards associated with electromagnetic waves. Students will use models of wave behavior to explain information transfer, using waves and the wave-particle duality. Using knowledge of waves, students will develop a system to warn populations of possible earthquakes.

Guiding Questions-

- How do we know what is inside Earth?
- Why do people get sunburned by UV light?
- How can we transmit information over wires and wirelessly?

Suggested Activities

- Students will observe wave properties of transverse and longitudinal in different mediums.
- Students will design a musical instrument and determine how wave properties change the output (frequency, amplitude, wavelength) and tune the instrument to a specified frequency so that an orchestra of peers can play a simple 4 note song.
- Students will research past natural disasters, work with materials to understand stress and faulting, test ocean waves vs tsunami wave properties, learn about seismic waves, how they affect us, test seismic engineering solutions, and learn about and test mitigation efforts for tsunamis.

Summary of Sample Assignment: Students will use long slinkys to observe wave pulses, wave interference, transverse waves, longitudinal waves, wave speed, and standing waves. Each group will have to present to the class a minimum of three claims based on their observations using the claim, evidence, reasoning structure.

Unit Lab Activities

In this activity, students will use a Slinky to model the structure and function of seismic waves (S-waves and P-waves) to visualize how they can be used to investigate the layers of Earth.

Suggested Assessment

Claim Evidence Reasoning

Scenario-
Photovoltaic (solar) cells are widely used to convert the Sun’s energy into electric current. Absorption of sunlight in a solar cell ultimately results in an electric current created by the movement of loose electrons from the atoms within the solar cell.

Prompt-
Does a photovoltaic device rely, at least in part, on the wave particle theory? State a claim and provide evidence and reasoning to explain whether the photovoltaic (solar) cell is relying on the wave model of light. Please include a rebuttal in your answer.

UNIT VI: Segment 6: Stars and the Origin of the Universe

Students apply their model of nuclear fusion to trace the flow of energy from the Sun's core to Earth. Students will apply their knowledge of the doppler effect to the concept of redshift and blueshift in astronomy in order to defend a claim about the expansion of our universe.They will use evidence from the spectra of stars and galaxies to determine the composition of stars and construct an explanation of the origin of the Universe.

Segment Guiding Questions:

- How do we know what stars are made of?
- What fuels our Sun? Will it ever run out of fuel?
- Do other stars work the same way as our Sun?
- How do patterns in motion of the stars tell us about the origin of our Universe?

Standards Addressed

HS-ESS1-1 Develop a model based on evidence to illustrate the life span of the Sun and the role of nuclear fusion in the Sun's core to release energy that eventually reaches Earth in the form of radiation.

HS-ESS1-2 Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.

HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements.

Instructional Objectives

Students will be answer the following questions:

Scope	Driving Questions
The Sun	● How do the sun's layers and features affect the type and amount of radiation it produces? ● What is the relationship between radiation released from the Sun and events on Earth? ● Why does the mass of a star determine its life cycle?

The Big Bang	● How do scientists use a star's light spectrum and brightness to determine its composition, movement, and distance from Earth? ● What observations make it impossible for scientists to assume that matter and energy are distributed evenly throughout the universe in the Big Bang Theory? ● How does the relationship between the redshift of galaxies and their relative distances and speeds support the Big Bang Theory? ● How does the discovery of the cosmic microwave background radiation support the Big Bang Theory?
Stars & Elements	● What is conserved during the creation of elements by nuclear fusion? ● Why are more massive stars able to create higher-mass elements (up to iron) during fusion compared to average-mass stars? ● How do a star's temperature, luminosity, and color relate to its life cycle? ● Why is it possible to use the emission spectra of elements to identify the elemental composition of stars? ● How does a star's brightness relate to its distance from Earth?

Suggested Activities

Scope	Activity
The Sun	<u>Explore 1: Solar Composition and Processes</u> *Students will do internet research on the composition of the Sun, the process of radiation, the types of radiation emitted from the Sun, how energy is released by the Sun, and how that radiation gets to Earth. Students should recognize the relationship between solar and Earth systems.* <u>Explore 2: Solar Cycles</u> *Students will collectively use data to create a model of solar activity based on sunspot numbers since the year 1700. Groups will choose a period of high solar activity and research events on Earth that correlate to the solar activity, demonstrating a relationship between the energy released from the Sun reaching Earth and events on Earth.* <u>Explore 3 - Life Cycle of the Sun</u> *Students will perform a kinesthetic model to illustrate the changes that occur in a star during its life cycle. This will be done for both a low- to medium-mass star and a high-mass or a massive star.*

	Students will learn that the lifespan of stars is based primarily on initial mass and that the Sun is a low- to medium-mass star with a 10 billion-year life span. Students will also learn about the hydrogen-to-helium product and how that predicts a star's age.
The Big Bang	Explore 1: A Stretch of the Imagination *Students will model the expansion rate of the galaxies in the universe and construct an explanation based on valid and reliable evidence obtained from various sources.* Explore 2: Cosmic Confetti *This activity allows students to look at essentially raw data in order to formulate a working explanation for the big bang theory based on the model they observe.* Explore 3 - Modeling & Calculating Redshift *Students will create a human model of the redshift in light peaks from a receding star and the blueshift in light peaks from an approaching star and write a scientific explanation (CER) of this model and its limitations. Hubble's equation will be used to calculate the difference between the emitted light wavelength of a galaxy and the light frequency observed on Earth.* Explore 4 - Cosmic Microwave Background Radiation *In this two-part activity, students will interpret statements to support the big bang theory and make a model to explain the source of cosmic microwave background radiation.*
Stars & Elements	Explore 1: Element Smash *In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. Students will simulate the proton-proton chain reaction, both kinesthetically and using marshmallows, to show how matter cannot be created or destroyed, only moved between systems.* Explore 2: Fusion Fun *Students model how elements are created in the cores of high-mass stars by building a clay model and describing the process. Students write a scientific explanation (CER) of the formation of elements and production of energy in this process.* Explore 3 - Star Relationships *Students will create a large Hertzsprung-Russell (H-R) diagram on the board and then shade their own smaller version based on data to study the relationships between a star's temperature, luminosity (absolute brightness), and color and how these relate to the star life cycle.* Explore 4 - Star Fingerprints *Students view the spectra produced by different known elements and compare the spectra with that of an unknown star to determine the elements present.*

	Explore 5 - Absolute & Apparent *Students will measure the absolute brightness (luminosity) and apparent brightness of a light source, then calculate the distances of stars from Earth using apparent brightness and the H-R diagram.*

Suggested Assessment

Students create a timeline poster that details exactly how the universe transitioned from a hot soup of atoms to one of stars, galaxies, and planets.

Sacramento City Unified School District

COURSE OF STUDY

FOR

The Living Earth (Biology w/ Earth Science)
QBS260, QBS261

Segment	High School
Length of Course	One Year
Developed by	*SCUSD Teacher Committee* *Aaron Pecho, Science Coordinator* *Janna Cantwell, Training Specialist*
First Edition	*Fall, 2020*

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

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BIOLOGY: THE LIVING EARTH

SECTION ONE — GENERAL INFORMATION

COURSE DESCRIPTION

Through the lens of the science and engineering practices and the cross-cutting practices identified in the California NGSS, students will study the biological concepts of ecosystems, genetics, evolution and cells to organisms. Standards of Earth and space science such as Earth's history and global climate change will also be used to deepen student understanding of the concepts that are being learned. Students will spend a minimum of 20% of classroom time engaged in hands-on laboratory investigations that support instruction.

RATIONALE

Biology is the study of life, which makes this course one of the most important required subjects. Students who take this class will have a greater understanding of how their bodies' function and will appreciate the outside world in a new way. They will gain experience in scientific practices and theories which will prepare them for the physical sciences of chemistry and physics.

COURSE GOALS

Upon completion of Segment 1 (Ecosystem Interactions and Energy) students will be able to use mathematical and computer models to determine the factors that affect the size and diversity of populations in ecosystems, including the availability of resources and interactions between organisms. In addition, students will be able
to answer the following questions:

1. What factors affect the size of populations within an ecosystem?
2. What are common threats to remaining natural ecosystems and biodiversity?
3. How can these threats be reduced?
4. What type of behaviors do animals exhibit that help them survive?

Upon completion of Segment 2 (Earth’s Atmosphere)
Students will make links between photosynthesis and respiration in organisms and cycles of energy and matter in Earth systems. In addition, they will address the following driving questions:

1. How do living things acquire energy and matter for life?
2. How do organisms store energy?
3. How are photosynthesis and cellular respiration connected?

4. How do organisms use the raw materials they ingest from the environment?
5. How has the cycling of energy and matter changed over Earth's history?
6. How has the interaction and evolution of species impacted Earth and its atmosphere?

Upon completion of Segment 3 (Evidence for Evolution) students will be able to develop a model of how rock layers record evidence of evolution as fossils. Building on their learning from previous grades, they will focus on effectively communicating this evidence and relate it to principles of natural selection. In addition, they will also be able to answer the following questions:

1. How do layers of rock form and how do they contain fossils?
2. Why do we find matching fossils in places all over the world, but different modern organisms in those same places?
3. What evidence shows that different species are related?

Upon completion of Segment 4 (Inheritance of Traits) students will be able to develop explanations about the specific mechanisms that enable parents to pass traits on to their offspring. In addition, they will also be able to answer the following questions:

1. How are characteristics of one generation passed to the next?
2. What allows traits to be transmitted from parents to offspring?
3. How does variation affect a population under selective pressures?

Upon completion of Segment 5 (Structure, Function, and Growth) students will be able to use models to create explanations of how cells use DNA to construct proteins, build biomass, reproduce, and create complex multicellular organisms; they will also investigate how these organisms maintain stability. In addition, they will be able to answer the following questions:

1. What happens if a cell in our body dies?
2. How does the structure of DNA affect how cells look and behave?
3. How do systems work in a multi-celled organism, and what happens if there is a change in the system?
4. How do organisms survive even when there are changes in their environment?

Upon completion of Segment 6 (Ecosystem Stability and the Response to Climate Change) students will be able to use computer models to investigate how Earth's systems respond to changes, including climate change. They will also make specific forecasts and design solutions to mitigate the impacts of these changes on the biosphere. In addition, they will be able to answer the following questions:

1. What affects changes in ecosystems that ultimately affect populations?
2. What are the changes that are happening in the climate, and what effects are those having on life?
3. How are human activities impacting Earth's systems, and how does that affect

life on Earth?

4. What can humans do to mitigate their negative impact on the environment?

COURSE STANDARDS

LIVING EARTH INSTRUCTIONAL SEGMENT 1: ECOSYSTEM INTERACTIONS AND ENERGY

- **HS-LS2-1** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales
- **HS-LS2-2** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales
- **HS-LS2-4** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem
- **HS-LS2-8** Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce

LIVING EARTH INSTRUCTIONAL SEGMENT 2: EARTH'S ATMOSPHERE: PHOTOSYNTHESIS AND RESPIRATION

- **HS-LS1-5** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy
- **HS-LS1-6** Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/ or other large carbon-based molecules
- **HS-LS1-7** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy
- **HS-LS2-3** Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions
- **HS-LS2-5** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere
- **HS-ESS1-6**. 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
- **HS-ESS2-6** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere
- **HS-ESS2-7** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth
- **HS-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity *

LIVING EARTH INSTRUCTIONAL SEGMENT 3: EVIDENCE OF COMMON ANCESTRY AND DIVERSITY

- **HS-LS4-1** Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence

- **HS-LS4-2**. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment
- **HS-LS4-4**. Construct an explanation based on evidence for how natural selection leads to adaptation of populations
- **HS-LS4-5** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species
- **HS-ESS1-5** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks
- **HS-ESS2-5** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes
- **HS-ESS3-1** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity
- **HS-ESS3-4**. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems *
- **HS-ETS1-3** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts

LIVING EARTH INSTRUCTIONAL SEGMENT 4: INHERITANCE OF TRAITS

- **HS-LS3-1** Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring
- **HS-LS3-2** Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors
- **HS-LS3-3** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population
- **HS-LS4-2** Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment
- **HS-LS4-3** Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait

LIVING EARTH INSTRUCTIONAL SEGMENT 5: STRUCTURE, FUNCTION, AND GROWTH (FROM CELLS TO ORGANISMS)

- **HS-LS1-1** Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells
- **HS-LS1-2** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms
- **HS-LS1-3** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis
- **HS-LS1-4** Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms

LIVING EARTH INSTRUCTIONAL SEGMENT 6: ECOSYSTEM STABILITY AND THE RESPONSE TO CLIMATE CHANGE

- **HS-LS2-6**. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem
- **HS-LS2-7**. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity *
- **HS-LS4-5.** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species
- **HS-LS4-6.** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity *
- **HS-ESS3-5**. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems
- **HS-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity
- **HS-ETS1-1** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants
- **HS-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering
- **HS-ETS1-3** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts
- **HS-ETS1-4** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem

PLEASE NOTE: Sacramento City Unified School District, in alignment with California state standards, requires sexual health education for all high school students. If no health class exists, the 12 lesson segment on sexual health education is expected to be covered in Biology. Please consult your school site and district personnel for more information.
The district has adopted Advocates for Youth for its Sexual Health Curriculum, all lessons can be found here.

INSTRUCTIONAL MATERIALS

STEMscopes, Accelerate Learning

SUPPLEMENTARY MATERIALS:

3Rs Sexual Health Education (CHYA Compliant)

SUGGESTED AVERAGE TIME FOR COVERING MAJOR UNITS

1. HS The Living Earth: Segment 1: Ecosystem Interactions and Energy- 5 weeks
2. HS The Living Earth: Segment 2: Earth's Atmosphere: Photosynthesis and Respiration- 6 weeks
3. HS The Living Earth: Segment 3: Evidence of Evolution- 5 weeks
4. HS The Living Earth: Segment 4: Inheritance of Traits- 4 weeks
5. HS The Living Earth: Segment 5: Structure, Function, and Growth- 4 weeks
6. HS The Living Earth: Segment 6: Ecosystem Stability and the Response to Climate Change- 4 weeks
7. Sexual Health Education (if no other health class is provided at your school site)- 3 weeks

TEACHER RESOURCES

- Online access to the Teacher Version of the Accelerate Learning STEMscopes Online Platform
- SCUSD Sexual Health Education Curriculum

RECOMMENDED STUDENT RESOURCES

- Online access to the Student Version of the Accelerate Learning STEMscopes Online Platform
- STEMscopedia (Textbook)

SECTION TWO — COURSE UNITS

UNIT I: Ecosystem Interactions and Energy

In this unit, students will use mathematical and computer models to determine the factors that affect the size and diversity of populations in ecosystems, including the availability of resources and interactions between organisms. Individual and group behavior will be analyzed in order to determine the benefits to individual members of a population. Students will apply their knowledge of carrying capacity, animal behavior and

processes that enable matter to cycle and energy to flow in an ecosystem to determine what a species needs for survival.

Standards Addressed

HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Significant Connections to California's Environmental Principles and Concepts:

- Principle II: The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.
- Principle III: Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.
- Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Instructional Objectives

Students will be able to:
Use mathematical and computer models to determine the factors that affect the size and diversity of populations in ecosystems, including the availability of resources and interactions between organisms. Students are applying their knowledge of carrying capacity, animal behavior, and processes that enable matter to cycle and energy to flow in an ecosystem to determine what a new ecosystem would need in order for a species to survive.

Suggested Activities

Scope #1: Carrying Capacity

Assignment #1 - Explore 1: Factors Affecting Carrying Capacity: Students will be making predictions of whether various factors would increase or decrease the carrying capacity of an ecosystem.
Assignment #2 - Explore 2: Tuva - Hare and Lynx Populations: Students will use a simulation tool to analyze data in order to explain the predator-prey relationship between a lynx and a hare.

Assignment #3 - Explore 4: Ecosystem Resilience: Students will model the effects of a parasitic disturbance on a population to explore how diversity and size can affect the resilience of an ecosystem.
Assignment #4 - Math Connections - Carrying Capacity: The students will create and interpret graphs relating to population growth and competition.

Scope #2: Flow of Matter and Energy in the Ecosystem

Assignment #1 - Explore 2: Food Chain Game: Students will play a game to demonstrate how biomass is impacted as energy is transferred through a food chain.
Assignment #2 - Explore 3: Hunger Games: In this activity, students will use population numbers and a given food web to create a biomass pyramid. Then students will answer a CER on how energy flow and the cycling of matter is impacted by removing a species from an expanded food web.

Scope #3: Animal Behavior and Survival

Assignment #1: Explore 1: Animal Behavior: Students will complete a card sort to distinguish between individual and group behaviors in animals. They will also identify the benefits of each of the behaviors listed.
Assignment #2: Explore 2: Strange Behavior: Students will be provided with an animal behavior that they will have to research in order to make a claim with evidence and reasoning to evaluate how that behavior is beneficial for an individual or group behavior.

Suggested Assessment

Scope #1: Carrying Capacity

- **Claim-Evidence-Reasoning (CER):**

Scenario- The city council of Jacksonville, Montana, is considering turning some of its grassy areas into large ponds. Farmers have argued against this idea, because they are concerned that taking away too much of the grassy areas will hurt the sheep.
Prompt- Write a claim to counter the farmers' argument, using the data above. Make sure to include a rebuttal in your answer.

Scope #2: Flow of Matter and Energy in Ecosystems

- **Open-Ended Response Assessment:** 3 Questions

Scope #3: Animal Behavior and Survival

- **Claim-Evidence-Reasoning (CER):**

Scenario- Many fish live their entire lives with a school of other fish, while a Tasmanian devil lives alone, hunting for prey, such as fish.
Prompt- Write a scientific explanation about how individual and group behavior can affect the survival and reproduction of a species. Make sure to give clear examples in your reasoning.

End of Unit Assessment:

- 3D Interactive Assessment - Ecosystem Interactions and Energy

UNIT II: History of Earth's Atmosphere

(Students will make links between photosynthesis and respiration in organisms and cycles of energy and matter in Earth systems. Students will create models to understand the molecules that form the basis of the living earth. They will discover how this knowledge can be applied to our world to connect the past, the present, and the future. In sum, they will be able to understand the impact of biotic and abiotic factors on the changes in composition of the atmosphere over time by completing activities in photosynthesis, respiration, and the carbon cycles.

Standards Addressed

HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

HS-LS1-6 Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

HS-LS1-7 Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

HS-LS2-3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

HS-LS2-5 Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

HS-ESS1-6 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.

HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth.

HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Instructional Objectives

Students will be able to:

Students will make links between photosynthesis and respiration in organisms and cycles of energy and matter in Earth systems. They will discover how this knowledge can be applied to our world.

Suggested Activities:

Scope 1: Cellular Energy and the Atmosphere

Assignment #1 Explore 1 - Inputs and Outputs: Cellular Energy
Students will model the chemical equations of photosynthesis and cellular respiration to see how energy and matter are transferred and flow from process to process. They will also explore which process stores and releases energy for use in organisms.
Assignment #2 Explore 2- Elodea and Cellular Energy Investigation
Students will conduct an investigation and will write a CER to explain that plants carry out photosynthesis and cellular respiration.
Assignment #3 Explore 3: Anaerobic Respiration Investigation
Students will design a lab to investigate which variable will produce the most energy in alcohol fermentation.

Scope 2: Carbon and the Earth

Assignment #1 Explore 1: The Carbon Cycle Game
Students model how a carbon atom moves through the carbon cycle. They will also create a storyboard to illustrate the journey their carbon atom took.
Assignment #2 Explore 3: Building Biomolecules
Students will model how lipids, proteins, and nucleic acids are formed from glucose and other substances from the surrounding environment. They will then write a scientific explanation that includes a claim, evidence, and reasoning (CER) to answer the question, “If you lived only on a diet of sugars, could you survive?

Scope 3: Interaction of Organisms and Earth’s Systems

Assignment #1 Explore 1: Making Calcium Carbonate From Carbon Dioxide
Students model the formation of calcium carbonate and make the connection of how feedback systems affect the amount of carbon dioxide in the atmosphere, the amount of carbon available to marine organisms for shell construction, and the acidity of the ocean.
Assignment #2 Explore 2: Origin of Atmospheric Oxygen
Students research the origin of atmospheric oxygen and prepare a group poster that highlights the dynamic changes in our atmosphere from the formation of Earth through today. Afterward, students display posters for a gallery walk and share responses.

Suggested Assessments

Scope 1: Cellular Energy and the Atmosphere

Claim Evidence Reasoning (CER)

Prompt-
A student is testing out different plant foods in the experiment above. Food A contains 70% glucose, while Food B contains 50% glucose. Based on the data, the student concluded that Food B was better, because the plant grew more. Was the student's conclusion accurate?

Scope 2: Carbon and the Earth

Claim Evidence Reasoning (CER)
Prompt-
The diagram shows how carbon is cycled through the environment. What two processes are most important in maintaining this cycle? Make sure your claim is supported with evidence and reasoning. Include a rebuttal in your response.

Open-ended Response Assessment

Scope 3: Interaction of Organisms and Earth's Systems

Open-ended Response Assessment

End of Unit Assessment

Project Based Learning (PBL): All Systems Go!

UNIT III: Evidence of Evolution

Students will explain the process of evolution via natural selection. Students will analyze the different types of evidence, such as the fossil record, anatomical structures, DNA sequences and embryology, that support evolutionary theory and show common ancestry of species. They will be able to explain the evolutionary significance of an adaptation. Students will also correlate environmental changes to evolutionary changes, and explain how the contingent nature of evolution is seen in the fossil record. Students will also compare and contrast the genetic and environmental conditions throughout Earth's history that leads to the creation or extinction of species. Students will learn about the environmental factors that can affect biodiversity.

Standards Addressed

HS-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

HS-LS4-2 Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Significant Connections to California's Environmental Principles and Concepts:

- Principle I: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.
- Principle II: The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.
- Principle III: Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.
- Principle V: Decisions affecting resources and natural systems are complex and involve many factors.

Instructional Objectives

Students will be able to:

Students will explain the process of evolution via natural selection. Students will analyze the different types of evidence, such as the fossil record, anatomical structures, DNA sequences and embryology, that support evolutionary theory and show common ancestry of species. They will be able to explain the evolutionary significance of an adaptation. Students will also correlate environmental changes to evolutionary changes, and explain how the fossils provide evolutionary evidence for life on earth and the status of the environment

Suggested Activities

Scope 1: Evolution and Natural Selection

Assignment #1 Explore 1: Owl and Mouse. Differential survival activity. Students will roleplay a predator and hunt prey with different traits, collecting data about which traits become more common and which traits become less common over time.
Assignment #2 Explore 3: Environmental Influences and Natural Selection. Students will read about specific changes in a species and are asked to explain the environmental influences that led to those traits changing.

Scope 2: Evidence of Common Ancestry

Assignment #1 Explore 1 Fossil Formation: Students will explore how fossils form and the importance of fossils in determining common ancestry. Students will model fossil formation with a lab activity and compare the anatomical structures of extinct and living organisms.
Assignment #2 Explore 2 Evidence of Common Ancestry Stations: Students will visit various stations to analyze evidence of common ancestry such as including biogeography, anatomical, developmental, and molecular homologies.
Assignment #3 Explore 4 Evidence of Ancestry:: Students will research the different types of evidence used to explain an organism's evolutionary history and relatedness.

Scope 3: Biodiversity and the Environment

Assignment #1 Explore 1 Human Settlements: Students research the natural resources that influenced people to settle in certain areas, including some ancient cities and some of the largest cities in the United States.
Assignment #2 Explore 2 The Case of the Disappearing City Students will be given a scenario and data for a city that has suffered some loss of natural resources, change in climate, or natural hazards and will explain what happened to the city in terms of population size, distribution, and migration patterns. **Assignment #3 Math Connections -** Human Dependence on Earth: Students will be able to use basic mathematical and algebraic skills in order to evaluate a solution to a complex, real-world problem (water availability) based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Suggested Assessments
Scope 1- Natural Selection Assessment: Open Ended Response Students will explain how evolution and natural selection are linked, and what factors influence evolution

Scope 2- Evidence of Common Ancestry Assessment: Open Ended Response Students will explain how shared structures support common ancestry and interpret a simple phylogenetic tree

Scope 3- Biodiversity and the Environment Assessment: Claim Evidence Reasoning Students will make a claim about how natural hazards have shaped human history and migration using data.

End of Unit Assessment: Segment 3 Mission Statement: Building a Model - Students use information gathered in these activities to build a model for how the fossil record forms and demonstrates evidence for evolution. They will use a claim-evidence-reasoning format to describe how their chosen fossil organism evolved and what common ancestors it shares with modern species.

UNIT IV: Inheritance of Traits

Students develop explanations about the specific mechanisms that enable parents to pass traits on to their offspring. They make claims about which processes give rise to variation in deoxyribonucleic acid (DNA) codes and calculate the probability that offspring will inherit traits from their parents. Students will study the specific mechanisms that enable parents to pass traits on to their offspring and will discover how this knowledge can be applied to our world.

Standards Addressed

HS-LS3-1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

HS-LS3-2 Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

HS-LS4-2 Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-3 Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Instructional Objectives

Students will be able to:

Develop explanations about the specific mechanisms that enable parents to pass traits on to their offspring. They make claims about which processes give rise to variation in deoxyribonucleic acid (DNA) codes and calculate the probability that offspring will inherit traits from their parents. Students will study the specific mechanisms that enable parents to pass traits on to their offspring and will discover how this knowledge can be applied to our world.

Suggested Activities

Scope #1: Inheritance of Traits

Assignment #1 - Explore 2: Gene Expression
Using an example of DNA, students will explore how gene expression dictates cell function and how expression can be influenced by environmental factors. Students will explain how genes are affected by environmental factors in different types of animals.
Assignment #2 - Elaborate: TUVA Data Literacy, Amylase Production (Part 1)
Students will use data collected by George Perry and his colleagues to test their hypothesis that production of amylase corresponds to the number of AMY1 gene copies and that a diet rich in starch can favor selection of individuals with increased capacity for producing amylase (i.e., more AMY1 gene copies).

Scope #2: Variations in Traits

Assignment #1 - Explore 1: Gamete Formation
Students will determine the relationship between parent cells and gametes by modeling how gametes have a reduced number of chromosomes.
Assignment #2 - Explore 2: The Big Mix-Up During Meiosis
Students will model how meiosis leads to new genetic combinations and increased genetic variation through crossing-over.
Assignment #3 - Math Connections: Variation in Traits
The students will create a Punnett square to figure out the genotype and phenotype of offspring and will calculate the genotypic and phenotypic ratios from the chart.

Scope #3: Natural Selection and Traits

Assignment #1 - Explore 1: Genetic Variation
Students will examine the process of natural selection by analyzing the peppered moth populations before and after the Industrial Revolution in England. **Assignment #2 - Explore 2: Sickle Cell and Malaria**
In this investigation, students will explore how natural selection can change the allele frequencies of the distribution of the sickle cell trait in humans. Students will complete the investigation by analyzing how mutations such as the sickle cell mutation may contribute to evolution.

Assignment #3 - TUVA: Data Literacy - World Wildlife Populations
Students manipulate the TUVA data graphs to visualize the effect of natural selection on populations of wildlife around the world.

Suggested Assessment
Scope #1: Inheritance of Traits

- **Open-Ended Response Assessment:** 3 Questions

Scope #2: Variation in Traits

- **Open-Ended Response Assessment:** 3 Questions

Scope #3: Natural Selection and Traits

- **Claim-Evidence-Reasoning (CER)**

Peter and Rosemary Grant finch data scenario for beak depth and rainfall

End of Unit Assessment:

- 3D Interactive Assessment - Inheritance of Traits

UNIT V: Structure, Function and Growth

Students will use models to create explanations of how the function of a cell is dependent upon DNA; which codes for proteins that ultimately: build biomass, facilitate reproduction, and create complex singular as well as multicellular organisms. Furthermore, students will investigate how these organisms maintain stability (homeostasis) through complex systems involving feedback mechanisms.

Standards Addressed

HS-LS1-1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

Instructional Objectives

Students will be able to:

Students will use models to create explanations of how the function and structure of a cell is dependent upon DNA; which codes for proteins that ultimately: build biomass, facilitate reproduction, and create complex singular, as well as multicellular organisms. Students will be able to identify DNA, genes, and chromosomes and describe how they are related to each other by their function. Furthermore, students will investigate how these organisms maintain stability (homeostasis) through complex systems involving feedback mechanisms.

Suggested Activities

Scope #1: Cell Division and Complex Organisms

Assignment #1 Engage: Accessing Prior Knowledge
Students will use a copy of cell division to differentiate between Meiosis and Mitosis using a Venn diagram.
Assignment #2 Explore: When is the Cell Dividing? Students will construct a line graph of the amount of DNA during the cell cycle. Next, using the graph they constructed, they will draw a comic strip illustrating what happens to a cell during the cell cycle. Then, they will write a scientific explanation that includes a claim, evidence, and reasoning (CER) to answer the question, "Which frame of your comic strip represents the cell dividing?

Scope #2: DNA to Proteins:

Assignment #1 Explore 1: Components of DNA.
Students will construct a model of DNA using puzzle pieces and will identify the various components (sugar backbone, nucleotides (nitrogenous base pairs), phosphate group, and hydrogen bonds.
Assignment #2 Explore 2: Make Me a Sandwich.
Students will do an activity using the metaphor of sending a friend out to get a sandwich and relate it to how RNA codes and builds proteins.

Scope #3: Systems and Homeostasis

Assignment #1 Explore 1: 3-D Body System.
Students will create a 3-D model of an organ system. This model will allow for the development and organization of the organ system from the macroscopic to the microscopic level, including structure and function.
Assignment #2 Explore 4: Homeostasis in Plants.
Students will use inquiry to investigate homeostasis in plants. They will design, plan and carry out an investigation with guidance from the instructor.

Suggested Assessment
Scope #1: Cell Division and Complex Organisms
Claim Evidence Reasoning (CER)

Students look at the data and write a claim as to how the changes illustrated above occur. Students should write a CER that begins with a claim like The original cell in this illustration goes through mitosis to create two identical daughter cells that, along with genetic instructions, differentiate into different specialized cells.

Scope #2: DNA to Proteins
Open ended Response: 3 questions

Scope #3: Systems and Homeostasis
Claim Evidence Reasoning
Students will look at two different scenarios and write a scientific explanation for each; explaining what the body needs to regulate to reach homeostasis.

End of Unit Assessment
Students use models to create explanations of how cells use DNA to construct proteins, build biomass, reproduce, and create complex multicellular organisms. They investigate how these organisms maintain stability.

Unit VI: Ecosystem Stability & the Response to Climate Change

Students use computer models to investigate how Earth's systems respond to changes, including climate change. Students will analyze the effects that human activities have on the environment and biodiversity. They will make specific forecasts and design solutions to mitigate the impacts of these changes on the biosphere.

Standards Addressed

HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Significant Connections to California's Environmental Principles and Concepts:

- Principle I: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.
- Principle II: The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.
- Principle III: Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.
- Principle V: Decisions affecting resources and natural systems are complex and involve many factors.

Instructional Objectives

Students will be able to:
Students use computer models to investigate how Earth's systems respond to changes, including climate change. They make specific forecasts and design solutions to mitigate the impacts of these changes on the biosphere.

Suggested Activities:

Scope 1: Human Impacts on Ecosystems

Assignment #1 Explore 1: Are We Destroying the Planet?
Students will be exploring ways humans are impacting Earth. They will create a PSA to share with the class.

Assignment #2 Explore 4: Modeling the Spheres
Working in pairs, students will use computer simulations to create a computational model of the effect of human-generated carbon dioxide on the relationships between Earth systems. Using mathematical representations, students will communicate the effects of melting permafrost, new vegetative growth, wildfires, and human emissions have on the Earth. The models and mathematical representations will be used to predict changes in Earth's global climate.

Assignment #3 Explore 5: Factors Affecting Biodiversity:
Students will research an assigned ecosystem to determine which factors affect biodiversity the greatest. They will gather and synthesize their research onto a poster board to then present in a gallery walk and take a stance about which factor has the greatest impact on a global scale.

Scope 2: Climate and Ecosystems

Assignment #1 Explore 1: My Climate Forecast

Students will research a chosen topic: greenhouse gases, weather and climate, oceans, snow and ice. They will summarize the geoscience data provided on the website to

make predictions about our climate in the next 20 to 100 years. They will compare their predictions with other groups who researched the same topic and have a discourse with guidance from the instructor.

Assignment #2 Explore 2: Population Dynamics

In this activity, students will be given a scenario (addition of a new species to a community in an ecosystem), and asked to respond with a CER. Students will then be given a data set to evaluate. Using this data, students will then readdress the initial CER.

Assignment #3 Explore 4: What Does the Data Say?

Students will be presented with various types of data about the bee-colony population. They will analyze and interpret the data to make a claim about the causes of the population decline. Students will support their claim with the evidence that they have been provided. Students will share their claim and listen to the claim of other groups in order to make revisions.

Suggested Assessment

Scope 1: Human Impacts on Ecosystem

Claim Evidence Reasoning essay about the impacts of farmland and how to mitigate its impact on biodiversity.

Scope 2: Climate and Ecosystems

Open ended response Assessment: 3 questions

End of Unit Assessment

3-D Interactive Assessment: Ecosystem Stability and the Response to Climate Change

Sacramento City Unified School District

COURSE OF STUDY

FOR

Chemistry in the Earth System (Chemistry w/ Earth Science)
QCS300, QCS301

Segment	High School
Length of Course	One Year
Developed by	*SCUSD Teacher Committee* *Aaron Pecho, Science Coordinator* *Janna Cantwell, Training Specialist*
First Edition	*Fall 2020*

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

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CHEMISTRY IN THE EARTH SYSTEM

SECTION ONE — GENERAL INFORMATION

COURSE DESCRIPTION

Chemistry in the Earth System is a two semester, lab-based course that addresses the Next Generation Science Standards and is guided by the California Science Framework's High School 3-Course Model. It is a hands-on, inquiry based course, where students will explore chemical and earth science concepts through rigorous investigations. The chemical and earth science performance expectations are taught in an integrated manner to help students build deeper comprehension and correlate how chemical processes and Earth processes are interdependent. This course starts with an introductory segment on lab safety, followed by five instructional segments that are each centered around a real world phenomenon. Students learn by asking and answering essential questions about these phenomena. Concepts build on each other and are revisited throughout the course to build a deeper understanding of chemistry and earth processes.

This course meets the SCUSD high school graduation requirement for a physical science course and counts as a University of California A-G Lab Science course.

RATIONALE

Science is a continuing search for the truth in our highly developed and technologically advanced society. Any living organism must be considered to be a complex chemical system and part of our environment. To understand how life affects and is affected by our physical environment (the earth and its systems), we must have a basic understanding of Chemistry.

COURSE GOALS

> Upon completion of this course, students will be able to demonstrate mastery of the relevant Next Generation Science Standards.

COURSE STANDARDS

UNIT 1 - SEGMENT 1: COMBUSTION, HEAT AND ENERGY IN THE EARTH SYSTEM

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

HS-PS3-2. Develop and use 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 position of particles (objects).

HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperatures are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

UNIT 2 - SEGMENT 2: ATOMS, ELEMENTS, AND MOLECULES

HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

UNIT 3 - SEGMENT 3: CHEMICAL REACTIONS

HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

UNIT 4 - SEGMENT 4: CHEMISTRY OF CLIMATE CHANGE

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios *

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity

UNIT 5 - SEGMENT 5: THE DYNAMICS OF CHEMICAL REACTIONS AND OCEAN ACIDIFICATION

HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium *.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere

INSTRUCTIONAL MATERIALS

Moore, Christopher, Wysession, Michael, Lutes, Bryn. *Experience Chemistry in the Earth System*. Boston, MA; Pearson. 2021.

SUGGESTED AVERAGE TIME FOR COVERING MAJOR UNITS

- UNIT 0: CHEMICAL SAFETY (~4 class periods*)
- SEGMENT 1: COMBUSTION and HEAT AND ENERGY IN THE EARTH SYSTEM (~23 class periods total)
- SEGMENT 2: ATOMS, ELEMENTS, AND MOLECULES (~33 class periods)
- SEGMENT 3: CHEMICAL REACTIONS (~54 class periods)
- SEGMENT 4: CHEMISTRY OF CLIMATE CHANGE (~32 class periods)
- SEGMENT 5: THE DYNAMICS OF CHEMICAL REACTIONS AND OCEAN ACIDIFICATION (~32 class periods)

* *Assuming 178 class periods of 55 minutes each class.*

TEACHER RESOURCES

Teacher guide for *Chemistry in the Earth System* *Volume 1 (covers Instructional Segments 1,2, and 3)*. *Volume 2 (covers Instructional Segments 4 and 5)*

California Science Safety Handbook
English Language Development Standards NGSS Correlation (pages T98-T105)

FLINN SCIENTIFIC (HTTPS://WWW.FLINNSCI.COM/)

https://thewonderofscience.com/
California Education and Environment Initiative Science Curriculum Bank - "E" Units
California Department of Education NGSS Resources and Instructional Materials
CA Science Framework Description (Chemistry in the Earth System)

California Science Framework Chapter 7 Chemistry in the Earth System

RECOMMENDED STUDENT RESOURCES

BOZEMAN SCIENCE (HTTP://WWW.BOZEMANSCIENCE.COM/)
BRIGHTSTORM SCIENCE (HTTPS://WWW.BRIGHTSTORM.COM/SCIENCE/CHEMISTRY/)
CRASH COURSE CHEMISTRY (HTTPS://WWW.YOUTUBE.COM/PLAYLIST?LIST=PL8DPUUALJXTPHZZYUWY6FYEAX9MQQ8OGR)
ISAACS TEACH (HTTPS://WWW.YOUTUBE.COM/USER/ISAACSTEACH)
PHET SIMULATIONS: HTTPS://PHET.COLORADO.EDU/

SECTION TWO — COURSE UNITS

UNIT 0: Safety in the chemical laboratory

The students enrolled in this course will, by necessity, be handling dangerous chemicals as they conduct the various laboratory activities/experiments in this course. It is necessary that all safety precautions involved in using such chemicals be observed. It is essential, therefore, that the class size not exceed the number of laboratory stations available to the students. Each laboratory must be equipped with a proper fire extinguisher; fire blankets, safety shower, and eye wash stations. Each laboratory must have a fume hood and be so ventilated that the students will not be exposed to noxious gases that are generated in some of the laboratory experiments. All students should be equipped with OSHA approved eye protection, aprons and gloves when necessary for the various experiments. Each laboratory classroom should have a goggle sterilization cabinet to sterilize goggles in between class periods of students.

Teachers should be cautious not to exceed the suggested capacity of the room if laboratory activities are to be a regular part of the science courses to be taught there. Should overcrowding result from errors in scheduling, or due to administrative oversight, it is important that the teacher notify the principal, in writing, of the safety hazard that has been created. If the room is seriously overcrowded, the teacher should suspend laboratory activities until the problem has been corrected.

Additional recommendations with regards to laboratory safety:

1. All facilities should conform to federal, state, and local laws and guidelines as they pertain to the safety of students and instructors. Instructors should consult the California Science Safety Handbook for any questions regarding safety.

2. Chemistry students should not carry out laboratory experiments and demonstrations if they could expose the students to risks or hazards that are inappropriate for learning in the instructional sequence (e.g., explosion experiments that do not have any learning objective).

3. Students should be fully informed of potential laboratory hazards relating to chemicals and apparatus before performing specific experiments. Students themselves should research needed safety information in advance by using an SDS (Safety Data Sheet) database (*FLINNSCI.COM/SDS).* A hard copy of all SDS should be kept in the classroom for student and instructor use. SDS health and safety information should be a mandatory part of each student's lab write-up.

4. Storage and disposal of hazardous chemicals must always be done in accordance with local regulations and policies. As far as possible, the students as well as the instructor should know what these regulations are. An annual chemical inventory should be completed by the chemistry instructors at each site; a copy of which should be provided to the plant manager, the science department, school administration, and the

district safety/chemical hygiene officer. The district and site chemical hygiene officer should keep in regular contact with all classroom chemistry instructors to keep them abreast of hazardous chemical pick-up and disposal *information.*

A successful Chemistry laboratory program will instill in each student a true, lifelong "safety sense" that will ensure their safe transition into more advanced laboratory work in college or university laboratories or into the industrial workplace environment.

Students will be knowledgeable about and be able to carry out the following safety procedures:

- simple first aid for cuts, thermal and chemical burns;
- use of safety goggles, eye washes, safety showers, fire blankets, and fire extinguishers;
- safe handling of glassware, hot plates, burners and other heating devices, and electrical equipment;
- proper interpretation of SDS and hazard warning labels; and
- proper use and reuse practices (including proper labeling of interim containers) for reagent bottles.

Standards addressed

The American Chemical Society (Chemical Science Safety in the Classroom)

- Chemical Safety for Teachers and Their Supervisors
- Guidelines and Recommendations for the Teaching of High School Chemistry
- Chemical Health & Safety Resources

California Science Safety Handbook

OSHA: https://www.osha.gov/laws-regs/regulations/standardnumber

Instructional Objectives

Students will be able to determine which safety procedures are relevant for each laboratory activity and successfully implement their use to maintain the health and safety of themselves, their peers and their instructor.

Suggested Activities

- Safety lab - rotating stations demonstrating various safety techniques, procedures and “dangers”
- Students and their parents/guardians will be required to sign a safety contract before being allowed to participate in laboratory activities.
- Watch safety videos: Pearson Realize has a series of 8 Flinn safety videos provided in the Lab Resource Center available online.
    1. Introduction to Laboratory Safety
    2. Prelab Safety
    3. Safety equipment
    4. Personal Protective Equipment
    5. Chemical Labels and Safety Data Sheets

6. Responsible Chemical Disposal
7. Common Lab Procedures
8. Exposure Response

Flinn Scientific Safety video for physical sciences is available on youtube:
https://www.youtube.com/watch?v=HLaOJKD9iDg&t=187s

A“fun” safety video is “The Accident at Jefferson High” (18:28) available on youtube.
https://youtu.be/S0QnsJV2d3E

Other safety videos made by Flinn scientific are available at this link:
https://www.youtube.com/results?search_query=flinn+scientific+safety+video

Teachers should visit https://labsafety.flinnsci.com/ and create an account to be able to access safety contracts, safety tests and other safety reference materials. Teachers can also follow this link for quick access to a safety test and safety contract.

To accommodate students with disabilities please refer to state, local and district guidelines. A useful reference is *Teaching Chemistry to Students with Disabilities* Thomas J. Kucera; Editor published by the American Chemical Society. August 1993 (3rd edition). ISBN 0-8412-2734-9

Suggested Assessment
Students will be required to demonstrate understanding of laboratory safety - this could include but is not limited to a safety test. Students should be given the opportunity to retake the test as many times as necessary to achieve a perfect score; safety is not optional. The assessment should also include a “map of the laboratory classroom” requiring students to pinpoint the location of all safety equipment to include eye washes, safety showers, goggle sterilization cabinet(s), safety blanket, first aid kit, fire extinguisher(s), chemical waste containers and all exits.

UNIT 1 - Segment 1: Combustion, Heat, and Energy in the Earth System

In this instructional segment, students are introduced to the concept of energy as it relates to chemistry and earth science. They explore energy in its different forms, how it can be measured and how it can be converted from one form to another. They investigate combustion reactions, geothermal energy as a way to produce electricity and heat transfer as it relates to processes at work in the earth's atmosphere, surface and interior.

Standards Addressed

HS-PS1-3
HS-PS1-4
HS-PS1-7
HS-PS3-1
HS-PS3-2
HS-PS3-4
HS-ETS1-4
HS-ESS2-3

Instructional Objectives

Students will be able to answer the following **essential questions** via the corresponding *competencies*:

Why are wildfires so difficult to extinguish?

1. *Students will identify factors that sustain a combustion reaction.*
2. *Students will identify products of combustion reactions and how mass is conserved even when it does not appear to be.*
3. *Students will draw connections between wildfires and natural gas fires.*
4. *Students will make a connection between the chemical energy stored in fuel and in food.*

How does California get electricity from geothermal energy?

5. *Students will identify the various forms that energy can take including kinetic, potential, chemical, thermal, electromagnetic, electrical and mechanical.*
6. *Students will describe the sequence of energy transformations that take place as thermal energy into electrical energy*

Why are there so many volcanoes in California?

7. *Students will use the principles of plate tectonics and understanding of the layers of the Earth's interior to explain the phenomena of volcanoes.*
8. *Students will identify and describe methods of heat transfer including conduction, convection and radiation*

Suggested Activities

For the purposes of designating useful information about the assignments, a coded label system is used. This system will be used throughout all of the different units.

[+] - This activity is designated by the Pearson teacher's manual as an additional, more in depth, optional assignment.
[★]- This activity is part of the core experiences set of labs kit or the performance assessments kit where Flinn lab materials are provided by the district.
[#] - This activity is not provided as part of the core experiences but utilizes materials that are commonly found or easily accessible in most chemistry lab classrooms.

Some labs have specific information pertaining to teaching students with special needs, struggling students, ELD students, and advanced students. These will be noted with the following superscript numbers:
[1] - This activity provides support for teaching students with special needs.
[2] - This activity provides support for teaching students who are struggling.
[3] - This activity provides support for teaching students who are advanced.
[4] - This activity provides support for teaching students who are developing their English skills.

Key Assignments may include:

Problem Based Learning/Web Research

- Coal Fire at the Seam +

Authentic Readings/Worksheets

- Learn More About Wildfires Reading/Learn More About Wildfires Worksheet **+**
- Supercharged geothermal energy could power the planet/Worksheet +

Labs

- Energy Densities of Organic Fuels ★
- Measure Energy Flow in Chemical Reactions ★
- Matter Transformation in Combustion #
- Introduction to Electromagnetism
- Thermal Energy and Heat Transfer ★,**[4]**
- Evaluate the Thermal Equilibrium of Metals **#**
- Observe Convection Currents #
- Rise and Fall of Pangaea ★

Computer Simulations

- Virtual Lab: Conservation of Mass During Combustion **+**
- Virtual Lab: Measuring Energy in Food **+**
- PhET Interactive Simulation: Energy Forms and Changes
- Virtual Lab: Measuring Heat Conduction **+**

Analyzing Data

- Analyze Food Labels for Energy Content **+**
- Pendulums and the Conservations of Energy **+,[2],[3]**
- Assess California's Energy Supply **+,[2],[3]**
- Compare the Efficiency of Light Bulbs **+**
- Compare Heat Capacities **+,[2],[3],[4]**
- Evidence from Earthquakes **[2],[3]**

- Tracking Plate Movement **+**

Modeling Activities
- Model Chemical Potential Energy **[4]**
- Model Examples of Energy Flow **[4]**
- Model Energy Transfer and Conservation (Geysers)
- Modeling Energy in Different Forms **[1],[2]**
- Model Environmental Convection
- Convection in the Mantle **[2],[3],[4]**

Engineering Design Challenge
- Energy Efficient Cookware **+,[4]**
- Conservation of Mass in Chemical Reactions **+**
- Build a Basic Generator **+**

CERs
- Discuss Changes in a Burning Log **[1],[3]**
- How to Boil Water
- Pitch Drop Experiment **[2],[3],[4]**

Writing About Science/Other Activities
- Physical Properties as Design Criteria **+**
- Modes of Heat Transfer
- Why do rocks melt under the ocean? **[1],[2],[3]**

Suggested Assessments
- 3D Assessment: Combustion-Matter, Energy, and Change
- Performance Based Assessment - Measuring the Energy in Combustion Reactions ★,**[2],[3]**
- 3D Assessment: Energy Transfer and Conservation
- Performance Based Assessment - Electricity and Wind Energy ★,[1],[3]
- 3D Assessment: Earth's Interior
- Performance Based Assessment - Investigate the Rock Cycle ★,[1],[2],[3]
- Pencil and paper teacher generated assessments

UNIT 2 - Segment 2: Atoms, Elements and Molecules

In this instructional segment, students explore electron energy levels, atomic orbitals, and electron configurations. They discover patterns in the periodic table and connect that to properties of the elements in the table. Students investigate different types of chemical bonds. They explore intermolecular forces and attractions between molecules.

Standards Addressed
HS-PS1-1
HS-PS1-2
HS-PS1-3
HS-PS1-7
HS-PS2-4
HS-PS3-5

Instructional Objectives
Students will be able to answer the following **essential questions** via the corresponding *competencies*:

What causes the colors in a fireworks display?

1. Students relate the properties of atoms to the differences in mineral properties, and the atomic emission spectra of elements to light emitted by fireworks.

Why are elements in pure form so rare?

2. *Students explain periodic trends of elements in relation to the differences in minerals.*

Why do gems have different properties than metals?

3. *Students explain how differences in bonding produce differences in properties of gems and metals and apply the knowledge to explain how minerals are distinguished from one another.*

Suggested Activities
Key Assignments may include:

Problem Based Learning/We Research

- Minerals, Crystals and Gemstones **+,[1],[2]**

Authentic Readings/Worksheets

- Firework Color Chemistry
- Meet 115: THe Newest Element on the Periodic Table **+**

Labs

- Flame Lab
- Bean Bag Isotopes
- Evaluate Atomic Spectra (Atomic Spectra Lab)
- Evaluate the Bohr model of the atom
- Model Electron Configuration★

- Develop a Periodic Table★
- Elements, Metals, Nonmetals and Metalloids
- Periodic Trends and Properties [1],[3]
- Characteristics of Ionic Bonds★,[4]
- Investigate Metallic Bonds
- Investigate Covalent Bonds★
- Intermolecular Forces
- Chemical Names and Formulas★
- Dehydrate Copper Sulfate Pentahydrate
- Comparing and contrasting mineral families (gem variations)

Computer Simulations

- Build an Atom - PhET Simulation
- Isotopes and Atomic Mass - PhET Simulation
- Rutherford Scattering - PhET Simulation
- The Quantum Mechanical Model and Atomic Orbitals **+**
- Ions and Electroplating +
- Predict Reactivity Using Periodic Trends **+,[2],[3]**
- Coulomb's Law - PhET Simulation
- Molecule Polarity - PhET Simulation
- Molecule Shapes - PhET Simulation
- Intermolecular Forces in Liquids **+**
- Atomic Interactions - PhET Simulation

Analyzing Data

- Explore Atomic Particles **+**
- Intensive and Extensive Properties **+**
- Explore Bohr Model Patterns **+**
- Patterns in Electron Configurations **+**
- Graphing Periodic Properties **+,[1],[4]**
- Size, Trends and Shielding Effect **+,[2],[3]**
- Patterns in Melting Points of Metals **+**
- Calculate Bond Polarity **+**
- Investigate Molecule Polarity **+,[2],[3]**
- Infer Rules for Naming Compounds **+,[1],[2]**
- Infer Rules for Naming Acids **+**

Modeling Activities

- Model Isotopes **[2],[3],[4]**
- Modeling Atomic Structure
- Modeling Electron Configurations **[1],[2]**
- Electron Dot Structures for Ionic Compounds **[2],[3]**
- Electron Dot Structures for Molecular Substances

Engineering Design Challenge

- Build a spectroscope from household materials **+,[1]**

- Growing Crystals in Gels **+,[1],[2]**
- Evaluate Metals for a Commercial Application **+, [1],[2],[3]**

CERs

- Emission Spectra of Elements **[2],[3],[4]**
- The Periodic Table
- Evaluate Atomic Models **[1],[3]**
- Periodic Trends **[1],[2],[3]**
- Electron Configuration and Element Properties **[2],[3],[4]**
- Effective Nuclear Charge and Electron Shielding **[4]**
- Chemical Bonding
- Compare Metallic and Ionic Substances **[1],[2],[3],[4]**
- Compare Molecular Compound Properties **[1],[3],[4]**
- Comparing Compound Nomenclatures

Writing about Science/Other Activities

- The History of Atomic Models **+**
- Properties of Atoms: Size vs Mass **+**
- Reflect on Periodic Trends **+**
- Describe Ionic Bonding and Properties **+**
- Water's Behavior on Earth **+,[2],[3]**

Suggested Assessments

- 3D Assessment Atomic Spectra
- *Performance Based Assessment Evaluate Atomic Structure with Flame Tests* ★,[1]
- 3D Assessment The Periodic Table
- *Performance Based Assessment Gravimetric Analysis of Periodic Trends* ★,+,[1],[3]
- 3D Assessment Chemical Bonding
- *Performance Based Assessment Qualitative Analysis and Chemical Bonding* ★,[3]
- Pencil and paper teacher generated assessments

UNIT 3 - Segment 3: Understanding Chemical Reactions

In this instructional segment, students explore states of matter and phase changes. They investigate molar relationships and calculate percent composition of compounds. Students analyze different types of chemical reactions as they balance chemical equations. They complete chemical calculations on moles, mass, and volume. They explore energy in chemical bonds and analyze enthalpy in changes of state.

Standards Addressed

HS-PS1-2
HS-PS1-3
HS-PS1-4
HS-PS1-5
HS-PS1-7
HS-PS2-4
HS-PS3-5

Instructional Objectives

Students will be able to answer the following **essential questions** via the corresponding *competencies*:

How do we design materials for a specific function?

1. *Students identify properties of different states of matter and use this to better produce materials and foods.*

Why do we quantify matter in different ways?

2. *Students use their knowledge of molar and mass relationships to explain how to quantify different types of matter and to apply these calculations to producing better foods.*

How is energy obtained from chemical reactions?

3. *Students explain how energy is obtained from chemical reactions using knowledge of the different types of reactions. They apply this knowledge while explaining chemical reactions in food and how to produce better foods.*

What can make a recipe fail?

4. *Students apply knowledge of limiting and excess reagents to explain why a recipe fails. They also explain limiting and excess ingredients in foods.*

Why do you get hot when you exercise?

5. *Students use knowledge of system enthalpy to explain why we get hot when we exercise. They further apply this to enthalpy of foods and how to change it.*

Suggested Activities

Problem Based Learning/We Research

- The Chemistry of cooking and the properties of baked goods **+**

Authentic Readings/Worksheets

- Charging Ahead the Future of Batteries **+**
- Antarctica's Blood Red Waterfall **+**

Labs

- Correlate Material Properties and Bond Type
- Measure the Energy of a Phase Change ★
- Melt Ionic and Covalent Compounds ★
- Modeling Metals, Ceramics and Polymers
- Investigate Surface Tension
- Aqueous Solutions ★
- Describe Small Scale Matter Using the Mole ★
- Mole Ratios ★
- Determine an Empirical Formula ★
- Preparation of Solutions
- Evaluate Chemical Reactions ★
- Types of Chemical Reactions ★
- Predict Chemical Reactions **[1]**
- Identify Unknowns Through Stoichiometry
- Determination of Reaction Output ★
- Formation of Barium Iodate
- The Thermodynamics of Hand warmers ★,[2],[3]
- Hess's Law and the Combustion of Metal ★,[3]
- The Heat of Melting Ice

Computer Simulations

- States of Matter **+**
- States of Matter Basics – PhET Simulation
- Tough Tools **+**
- Mole Road Map **+**
- Making Dilutions **+**
- Concentrations – PhET Simulation
- Molarity – PhET Simulation
- Reactivity of Metals **+**
- Cation Meets Anion **+**
- Balancing Chemical Equations – PhET Simulation
- Limiting Reagent **+**
- Reactants, Products and Leftovers - PhET Simulation
- Temperature Changes in Chemical Reactions **+**
- Heat of Fusion **+**

Analyzing Data

- Analyze Phase Diagrams **+**
- Phase Change Graphs **+**
- Metals and Nonmetals: Data about their properties **+**
- The Density of Freezing Salt Water **+**

- Compare Intermolecular Forces in Fresh and Salt Water **+**
- Counting Atoms in One Gram **+**
- Identify an Element from its Molar Mass **+**
- Assess the Percent Composition in DNA **+**
- Solubility and Percent by Mass **+,[1],[2],[3]**
- Analyzing Chemical Reactions **+**
- Balancing Combustion Equations **+**
- Proportional Relationships in Chemical Reactions **+,[1],[2],[3]**
- Energy in Reactions +

Modeling Activities

- Phase Changes and Intermolecular Forces **[4]**
- Surface Tension and Polarity **[1],[2],[3]**
- Chemical Quantities
- Model Concentration's Effect on Conductivity [1],[2],[3]
- Model Molar Mass and Molar Volume **[1],[2],[3]**
- Model Percent Composition
- Model Measures of Concentration
- Chemical Reactions
- Modeling Chemical Reactions
- Thermochemistry
- Put it Together
- Chose a Practical Unit
- Energy Changes in Chemical Reactions
- Enthalpy Diagrams for Phase Changes **[2]**

Engineering Design Challenge

- Abrasive Compounds **+**
- Building a Better Bike **+**
- An Empirical Formula Challenge **+**
- Water Purification **+**
- Build a Film Canister Rocket **+**
- Flameless Heating Systems **+**

CERs

- Physical Properties of Materials **+**
- Relate Intermolecular Forces to States of Matter
- Discuss Melting Materials **[2],[3]**
- Make a Claim about Extruded Materials
- Discuss the Masses of one Mole **[2],[3]**
- Reaction Reasoning
- Predict Whether a Precipitate Will Form
- Stoichiometry
- A Measure of Success
- Compare Heats of Formation

Writing about Science/Other Activities

- States of Water **+, [1],[2]**

- Solubility and Temperature **+**
- Counting Tiny Objects **[1],[2],[3]**
- Track the Mass of Reactants and Products **+**
- Parts and the Whole **+,[2],[3]**
- A Scale that Reads Moles **+**
- Energy Input for the Rusting of Iron **+**
- Enthalpy of Reaction vs Phase Change **+**

Suggested Assessments

- 3D Assessment Physical Properties of Materials
- Performance Based Assessment: Road Deicers ★**[2],[3]**
- 3D Assessment Chemical Quantities
- Performance Based Assessment: Analysis of Basic Copper Carbonate ★**[1]**
- 3D Assessment Chemical Reactions
- Performance Based Assessment: Identify Evidence of a Chemical Reaction★**[2],[3]**
- 3D Assessment Stoichiometry
- Performance Based Assessment: The Stoichiometry of Filling a Balloon ★**[2],[3]**
- 3D Assessment Thermochemistry
- Performance Based Assessment: Enthalpy of a Neutralization Reaction ★**,[2],[3]**
- Pencil and paper teacher generated assessments

UNIT 4 - Segment 4: Chemistry of Climate Change

Students develop models of energy flow in Earth's climate. They revisit combustion reactions from IS1 to focus on emissions from fossil fuel energy sources. They apply models of the structures of molecules to explain how different molecules trap heat in the atmosphere. Students evaluate different chemical engineering solutions that can reduce the impacts of climate change.

Standards Addressed
HS-ESS2-2.
HS-ESS2-4.
HS-ESS2-6.
HS-ESS3-2.
HS-ESS3-5.
HS-ESS3-6.

Instructional Objectives
Students will be able to answer the following **essential questions** via the corresponding *competencies*:

What is causing drought in California?

1. *Students identify severe weather and evaporation feedback and use this to explain the cause of drought. They then apply this to why there is an increase in extreme weather events.*
2. *Students explain why the complete disappearance of a glacier is an example of a nonlinear tipping point and relate that to what causes drought in California.*
3. *Students explain why most of the world's deserts are located at the poles and relate that to the phenomenon of what causes drought in California.*
4. *Students analyze evaporation feedback and use this to refine explanations on what causes drought in California.*
5. *Students use their knowledge of climate zones to refine explanations on what causes drought in California.*
6. *Students apply knowledge of how humans have impacted climate to refine explanations on what causes droughts in California.*

What is causing an increase in floods?

1. Students use the greenhouse effect and climate models to explain the cause of an increase in floods. They apply this knowledge to an increase in other extreme weather events.

2. Students construct an explanation of how surface water might contribute to the greenhouse effect and relate that to the phenomenon of what is causing an increase in floods.

3. Students describe how melting ice could affect the frequency and intensity of flooding events.

4. Students describe how greenhouse gas emissions affect the frequency and intensity of flooding events.

5. Students explain what CESM projections predict about the likelihood of flooding in the future.

6. Students use knowledge of coastal flooding, droughts, and floods to refine explanations on what is causing an increase in floods.

7. Students describe engineering solutions to flooding and use this to refine explanations on what is causing an increase in floods.

Suggested Activities

Problem Based Learning/We Research

- Water as a Greenhouse Gas **+**

Authentic Readings/Worksheets

- An Unexpected Side-Effect of Drought **+**
- Geoengineering and Climate Change **+**

Labs

1. Feedback and Climate Change
2. Energy in the Atmosphere
3. Albedo and Composition of Earth's Surface
4. How Melting Ice Affects Sea Level ★
5. Observe Air Pollution
6. Carbon Dioxide and its Role in Climate
7. How Nature Records Changes in the Environment [1],[2]
8. Human Activity and Carbon Emissions ★
9. Model Climate Change with Melting Ice
10. Climate Change and Keeping Cool
11. Solar Cell Technology ★

Computer Simulations

- The Carbon Cycle **+**
- Sampling the Past **+**
- Molecules and Light – PhET Simulation
- Flow of Energy and Greenhouse Gases **+**
- Glaciers on Rainier **+**
- Climate Change and Fire **+**
- Energy Forms and Changes – PhET Simulation
- Wetlands and the Carbon Cycle **+**

Analyzing Data

- Influence of Dams on Coastal Erosion **+, [2]**
- Balance the Energy Budget **+**

- Energy In and Out of the Earth's Atmosphere **+, [1]**
- Historical Carbon Dioxide Levels **+,[1],[2]**
- Solar Output **+**
- Earth's Energy Equilibrium **+,[1],[2]**
- Volcanic Emissions and Climate Over Time **+**
- Tree Rings and Climate Change **+**
- Keeling Curve **+**
- Carbon Absorption **+,[2]**
- Climate Change and Drought **+**
- Climate Change and the Biosphere **+,[1],[3]**
- Ecological Footprint **+**

Modeling Activities

- Milankovitch Cycles **[1],[2],[3]**
- Carbon and the Atmosphere
- Interfering with the Carbon Cycle
- Graph Climate Change **[1],[2],[3]**
- Model Your Carbon Footprint

Engineering Design Challenge

- Design a Green Roof **+**

CERs

- Discuss the phenomenon: Drought Descriptors
- Feedback and Melting Glaciers
- Drought Causes **[2],[3]**
- Discuss the Wetland Effect
- Heat Expansion
- Drought Descriptors
- Ice Core: Records of Climate Change
- Sea Levels Rising **[2],[3]**
- Global Climate Change

Writing about Science/Other Activities

- Draft a Proposal to Reduce CO_2 Emissions **+, [3]**
- Snowball Earth **+, [1]**
- Reduce the Car Industry's Footprint **+**

****Additional and updated data and resources related to global climate change can be found with the following resources suggested by the California Framework:**

- Relevant CDE Resources
- Relevant EEI Resources

Suggested Assessments

- 3D Assessment Weather and Climate
- Performance Based Assessment: Microhabitat in a bottle ★

- 3D Assessment Global Climate Change
- Performance Based Assessment: Climate Change and the Carbon Cycle ★,[1],[3]
- Benchmark 3-D Assessment: Instructional Segments 4 and 5
- Pencil and paper teacher generated assessments

UNIT V - Segment 5 : Dynamics of Chemical Reactions and Ocean Acidification

Students investigate the effects of fossil fuel combustion on ocean chemistry. They develop models of equilibrium in chemical reactions and design systems that can shift the equilibrium between the air, water and carbonate shells of ocean creatures. Students conduct research on the interaction between ocean water and shell-building organisms.

Standards Addressed

HS-PS1-5.
HS-PS1-6.
HS-PS1-7.
HS-ESS2-2.
HS-ESS2-6.

Instructional Objectives

Students will be able to answer the following **essential questions** via the corresponding *competencies*:

How can you alter chemical equilibrium and reaction rates?

1. *Students use mathematics to calculate and explain reaction rates. They develop models of collision theory*
2. *Students develop a model of activation energy.*
3. *They design a solution for alternatives to the use of enzymes. Students use models to explain multistep mechanisms of reaction rates*
4. *Students relate chemical equilibrium to everyday examples. They explore Le Châtelier's principle. Students describe patterns in how temperature and pressure affect equilibrium.*

How can you predict the relative quantities of products in a chemical reaction?

5. *Students will utilize knowledge of Le Chatelier's principle to explain how increasing acidity of precipitation affects the processes that form limestone caves.*

How do limestone caves form?

6. *Students use reaction rates and energy diagrams to explain how limestone caves form.*
7. *They apply this toward explaining reactions that cause ocean acidification*

How does acid rain impact the environment?

8. *Students use acid-base reactions to explain how acid rain impacts the environment. They apply this knowledge towards explaining ocean acidification.*

What is happening to the world's coral reefs?

9. *Students use knowledge on ocean factors, such as pH and alkalinity, to explain what is happening to coral reefs and how humans contribute to ocean acidification*

Suggested Activities

Problem Based Learning/Web Research

- Reducing carbon footprints **+**

Authentic Readings/Worksheets

- Boring Sponges **+**

Labs

- Reaction rates: Iodine clock ★,[1],[2]or other comparable phenomenon
- Factors affecting rates of reaction #
- Collision theory
- Explore chemical equilibrium
- Equilibrium shifting **+,[1],[3]**
- Measure acid strength
- Titrations-The Study of Acid-Base Chemistry ★
- Analysis of Buffer Solutions and Ranges
- Quantitative Analysis of Acid Rain
- the pH of Seawater ★
- Carbon dioxide Levels in Water
- The Fate of Carbonate in Acidifying Oceans ★
- Ocean currents

Computer simulations

- Explore the relationship between collisions and activation energy **+**
- Reaction rates and activation energy **+,[2],[3]**
- Collisions and activation energy **+**
- Exploring Acid Strength and Concentration **+**
- acid and base solutions
- pH scale **[2],[3]**
- Explore buffer Systems **+,[1],[2]**
- Ocean pH simulation **+**
- El Niño, La Niña, and Heat Storage - (animation) **+**
- The Effect of Ocean acidification on shells **+**

Analyzing Data

- Factors that Affect Reaction Rate **+**
- Interpret Energy Diagrams +,[1],[2]
- Stoichiometric Analysis of Vinegar **+**
- Salt Hydrolysis **+**
- Pacific Ocean pH Changes **+**
- Greenhouse Gas Emissions and Climate Change **+**
- The Changing Ocean and the Biosphere **+**
- Correlating Flu outbreaks and La Niña weather patterns **+,[1],[3]**

Modeling Activities

- Model factors that affect reaction rate
- Reaction rate and molecular collisions **+**
- Compare equilibrium positions of weak acids
- Conductivity of strong and weak acids **+**
- Model an Acid-Base Titration [2],[3]
- Modeling Carbon Flow in the Ocean

Engineering Design Challenge

- Use Equilibrium for a commercial application **+**
- Design a natural pH indicator **+**
- Design a model of Ocean acidification **+**

CERs

- Discuss the Phenomenon of "A drop at a Time"
- The concept of activation energy
- Optimize a Reversible Reaction
- Discuss the phenomenon of Fishless lake in Adirondacks $^{+}$
- Acid Rain Tolerance
- The Changing Ocean and Coral Reefs
- Ocean Acidity **[2],[3]**
- Hurricanes and the Carbon Cycle
- Changing Climate and Ocean Ecosystems

Writing About Science/Other Activities

- Glow sticks and Reaction rate **+**
- Compare acid-base models **+**
- CO_2 Scrubbing **+**
- Earth's Position in Space Affects the Climate **[2],[3]**
- CO_2, Ocean acidification, and shell formation **+**

Problem-Based Learning Experience

- Reducing Carbon Footprints **+**

Suggested Assessment

- Performance based assessment relating reaction rates and equilibrium ★,[2],[3]
- Performance based assessment Quantitative analysis of acid rain ★,[1],[2]
- Performance based assessment Calcium carbonate and shell production ★,[1],[3]
- Interactive online quizzes provided by the publisher
- 3-D Assessment: Reaction Rates and Equilibrium
- 3-D Assessment: Acid-Base Equilibria
- 3-D Assessment: Ocean Acidification
- Benchmark 3-D Assessment: Instructional Segments 4 and 5
- Interactive ExamView 3-D assessment
- Pencil and paper teacher generated assessments

Sacramento City Unified School District

COURSE OF STUDY

FOR

Molecular Biology: The Living Earth (Molecular Bio. w/ Earth Science)
QBS262, QBS263

Segment	High School
Length of Course	One Year
Developed by	*SCUSD Science Teachers*
First Edition	*Fall 2020*

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

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Molecular Biology: The Living Earth

SECTION ONE — GENERAL INFORMATION

COURSE DESCRIPTION

Through the lens of the science and engineering practices and the cross-cutting practices identified in the California NGSS, students will study the biological concepts of ecosystems, genetics, evolution and cells to organisms with a special learning emphasis on molecular models and understandings. Standards of Earth and space science such as Earth's history and global climate change will also be used to deepen student understanding of the concepts that are being learned. Students will spend a minimum of 20% of classroom time engaged in hands-on laboratory investigations that support instruction. More specifically, Molecular Biology is an intensely inquiry-based, student driven approach to learning Biology. It is an experimental science that is designed as an alternative course to be taken in lieu of Biology. Students are given a more investigative hands-on approach through a Molecular lens. Lessons go deeper into the content, particularly in the areas of molecular biology and biochemistry and ask students to analyze data and explain phenomena more independently and on a deeper level. Students learn by "doing biology" by developing questions and seeking answers through open-ended lab investigations, observations, and data analysis. Students are challenged to think abstractly while learning the Next Generation Science Standards. Students more fully develop their critical thinking, writing, and communication skills as they produce formal, written reports and collaborate in lab groups.

RATIONALE

Students are not all the same. It is important to have a variety of course offerings for students so that they choose the design that best meets their learning needs and interests. Molecular Biology is a course that is designed as an alternative approach to learning Biology. It is heavily hands-on and investigation focused for students who seek to study Biology through a molecular lens and with a heavier emphasis on critical thinking. Molecular Biology specifically provides a more thorough application of the science and engineering practices associated with NGSS.

COURSE GOALS

Molecular Biology is a first year Biology course that satisfies the high school life science requirement, offering 10 credits upon its completion. The goal for the course is for students to learn the Biology: Living Earth curriculum standards with a molecular focus. Molecular Biology is focused on application and scientific use of present skills using a lab-based and critical thinking approach.

Upon completion of this course, students will be able to (SWBAT):

- *Segment 1:* SWBAT *Use mathematical and computer models to determine the factors that affect the size and diversity of populations in ecosystems, including the availability of resources and interactions between organisms.*
- *Segment 2:* SWBAT *Make a model that links photosynthesis and respiration in organisms to cycles of energy and matter in the Earth system. They will gather evidence about the linked history of Earth's biosphere and atmosphere.* **For a molecular focus**, they will emphasize the various energy, nutrient and resource cycles and the cellular energetic mechanisms that allow life on earth to proliferate. They will also understand chemical reactions in order to use a molecular lens to understand various homeostatic mechanisms that occur intracellularly.
- *Segment 3:* SWBAT *Develop a model about how rock layers record evidence of evolution as fossils. Building on their learning from previous grades, they will focus on effectively communicating this evidence and relating it to principles of natural selection.* **For a molecular focus**, students will understand variations of molecular heritable information as it relates to evolution on a deeper level (i.e. comparison of sequences of DNA/RNA, proteins).
- *Segment 4:* SWBAT *Develop explanations about the specific mechanisms that enable parents to pass traits on to their offspring. They make claims about which processes give rise to variation in DNA codes and calculate the probability that offspring will inherit traits from their parents.* **For a molecular focus,** students will explore the role and implications of mutations in cellular DNA. Students should also learn the underlying foundation of gene expression using mendelian and nonmendelian genetics in order to more fully understand dominance, codominance, sex-linked inheritance, multiple alleles, and polygenic inheritance on a molecular level.
- *Segment 5:* SWBAT *Use models to create explanations of how cells use DNA to construct proteins, build biomass, reproduce, and create complex multicellular organisms. They investigate how these organisms maintain stability.* **For a molecular focus**, students learn a more detailed understanding of the molecular process of protein synthesis (transcription and translation), cellular division, differentiation and feedback mechanisms. Students look closely at the properties of proteins and role in the proliferation of life. Students will discover how epigenetic changes can turn the expression of genes "on" or "off," the environmental factors that might influence epigenetics, and how epigenetic changes can be inherited from previous generations.
- *Segment 6:* SWBAT *Use computer models to investigate how Earth's systems respond to changes including climate change. They make specific forecasts and design solutions to mitigate the impacts of these changes on the biosphere.***For a molecular focus**, students will explore the impacts of climate change at a molecular scale. Learning will extend conceptual models to include more molecular characteristics and features of atmosphere and climate.
- *Sexual Health Education:* SWBAT *understand gender, make healthy decisions about sex and relationships, understand their rights and responsibilities, being able to plan and prevent the transmission of sexually transmitted infections*

including HIV, know thier options for planning and/or preventing pregnancy including the proper use of condoms, and understand how to prevent abuse and human trafficking.

COURSE STANDARDS

The science and engineering practices are what students DO to make sense of phenomena. They are both a set of skills and a set of knowledge to be internalized. These practices reflect the major practices that scientists and engineers use to investigate the world and design and build systems. They are to be used within each learning segment in order to ensure students can apply the biological content. The practices are summarized below.

- **Asking questions and defining problems** in 9–12 builds on grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
- **Developing and Using Models** *in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).*
- **Planning and carrying out investigations** in 9-12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
- **Analyzing and interpreting data** in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
- **Using Mathematics and computational thinking** in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
- **Constructing explanations and designing solutions** in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
- **Engaging in argument from evidence** in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
- **Obtaining, evaluating, and communicating information** in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

(LIVING EARTH INSTRUCTIONAL SEGMENT 1: ECOSYSTEM INTERACTIONS AND ENERGY

- **HS-LS2-1** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales

- **HS-LS2-2** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales
- **HS-LS2-4** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem
- **HS-LS2-8** Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce

LIVING EARTH INSTRUCTIONAL SEGMENT 2: EARTH'S ATMOSPHERE: PHOTOSYNTHESIS AND RESPIRATION

- **HS-LS1-5** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy
- **HS-LS1-6** Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/ or other large carbon-based molecules
- **HS-LS1-7** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy
- **HS-LS2-3** Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions
- **HS-LS2-5** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere
- **HS-ESS1-6**. 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
- **HS-ESS2-6** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere
- **HS-ESS2-7** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth
- **HS-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity *

LIVING EARTH INSTRUCTIONAL SEGMENT 3: EVIDENCE OF COMMON ANCESTRY AND DIVERSITY

- **HS-LS4-1** Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence
- **HS-LS4-2**. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment
- **HS-LS4-4**. Construct an explanation based on evidence for how natural selection leads to adaptation of populations
- **HS-LS4-5** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some

species, (2) the emergence of new species over time, and (3) the extinction of other species
- **HS-ESS1-5** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks
- **HS-ESS2-5** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes
- **HS-ESS3-1** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity
- **HS-ESS3-4**. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems *
- **HS-ETS1-3** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts

LIVING EARTH INSTRUCTIONAL SEGMENT 4: INHERITANCE OF TRAITS

- **HS-LS3-1** Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring
- **HS-LS3-2** Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors
- **HS-LS3-3** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population
- **HS-LS4-2** Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment
- **HS-LS4-3** Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait

LIVING EARTH INSTRUCTIONAL SEGMENT 5: STRUCTURE, FUNCTION, AND GROWTH (FROM CELLS TO ORGANISMS)

- **HS-LS1-1** Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells
- **HS-LS1-2** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms
- **HS-LS1-3** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis
- **HS-LS1-4** Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms

LIVING EARTH INSTRUCTIONAL SEGMENT 6: ECOSYSTEM STABILITY AND THE RESPONSE TO CLIMATE CHANGE

- **HS-LS2-6**. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem
- **HS-LS2-7**. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity *
- **HS-LS4-5.** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species
- **HS-LS4-6.** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity *
- **HS-ESS3-5**. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems
- **HS-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity
- **HS-ETS1-1** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants
- **HS-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering
- **HS-ETS1-3** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts
- **HS-ETS1-4** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

PLEASE NOTE: Sacramento City Unified School District, in alignment with California state standards, requires sexual health education for all high school students. If no health class exists, the 12 lesson segment on sexual health education is expected to be covered in Molecular Biology. Please consult your school site and district personnel for more information. The district has adopted Advocates for Youth for its Sexual Health Curriculum, all lessons can be found here.

INSTRUCTIONAL MATERIALS

STEMscopes, Accelerate Learning

SUPPLEMENTARY MATERIALS:

Supplemental materials can be found at the end of each learning segment.
3Rs Sexual Health Education (CHYA Compliant)

SUGGESTED AVERAGE TIME FOR COVERING MAJOR UNITS:

1. HS The Living Earth: Segment 1: Ecosystem Interactions and Energy- 3 weeks
2. HS The Living Earth: Segment 2: Earth's Atmosphere: Photosynthesis and Respiration- 8 weeks
3. HS The Living Earth: Segment 3: Evidence of Evolution- 5 weeks
4. HS The Living Earth: Segment 4: Inheritance of Traits- 8 weeks
5. HS The Living Earth: Segment 5: Structure, Function, and Growth- 5 weeks
6. HS The Living Earth: Segment 6: Ecosystem Stability and the Response to Climate Change- 3 weeks
7. Sexual Health Education- 3 weeks

TEACHER RESOURCES

STEMScopes, Accelerate Learning

RECOMMENDED STUDENT RESOURCES

STEMScopes, Accelerate Learning

SECTION TWO — COURSE UNITS

UNIT I: Ecosystem Interactions and Energy

In this unit, students will use mathematical and computer models to determine the factors that affect the size and diversity of populations in ecosystems, including the availability of resources and interactions between organisms. Individual and group behavior will be analyzed in order to determine the benefits to individual members of a population. Students will apply their knowledge of carrying capacity, animal behavior and processes that enable matter to cycle and energy to flow in an ecosystem to determine what a species needs for survival.

Standards Addressed

HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Significant Connections to California's Environmental Principles and Concepts:

- Principle II: The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.
- Principle III: Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.
- Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Instructional Objectives

Students will be able to:

In this unit, students will use mathematical and computer models to determine the factors that affect the size and diversity of populations in ecosystems, including the availability of resources and interactions between organisms. Individual and group behavior will be analyzed in order to determine the benefits to individual members of a population. Students will apply their knowledge of carrying capacity, animal behavior and processes that enable matter to cycle and energy to flow in an ecosystem to determine what a species needs for survival.

Suggested Activities:

Scope #1: Carrying Capacity

Assignment #1 - Explore 1: Factors Affecting Carrying Capacity: Students will be making predictions of whether various factors would increase or decrease the carrying capacity of an ecosystem.

Assignment #2 - Explore 2: Tuva - Hare and Lynx Populations: Students will use a simulation tool to analyze data in order to explain the predator-prey relationship between a lynx and a hare.

Assignment #3 - Explore 4: Ecosystem Resilience: Students will model the effects of a parasitic disturbance on a population to explore how diversity and size can affect the resilience of an ecosystem.

Assignment #4 - Math Connections - Carrying Capacity: The students will create and interpret graphs relating to population growth and competition.

Scope #2: Flow of Matter and Energy in the Ecosystem

Assignment #1 - Explore 2: Food Chain Game: Students will play a game to demonstrate how biomass is impacted as energy is transferred through a food chain.

Assignment #2 - Explore 3: Hunger Games: In this activity, students will use population numbers and a given food web to create a biomass pyramid. Then students will answer a CER on how energy flow and the cycling of matter is impacted by removing a species from an expanded food web.

Scope #3: Animal Behavior and Survival

Assignment #1: Explore 1: Animal Behavior: Students will complete a card sort to distinguish between individual and group behaviors in animals. They will also identify the benefits of each of the behaviors listed.

Assignment #2: Explore 2: Strange Behavior: Students will be provided with an animal behavior that they will have to research in order to make a claim with evidence and reasoning to evaluate how that behavior is beneficial for an individual or group behavior.

Additional hands-on activities/labs and interactive demonstrations for increased student engagement:

- Case study analysis & class discussion (**HS-LS2-1, HS-LS2-2, HS-LS2-8)** : The wolves & moose of Isle Royale
- Class Demonstration & discussion (**HS-LS2-4)**: Green water demonstration
- Class Demonstration & discussion (**HS-LS2-4)**: Ecosphere
- Small group analysis & discussion (**HS-LS2-4)**: Biomass pyramid graphs
- Small group activity (**HS-LS2-4)**: Bucket Brigade.

Suggested Assessment

Scope #1: Carrying Capacity

- **Claim-Evidence-Reasoning (CER):**

Scenario- The city council of Jacksonville, Montana, is considering turning some of its grassy areas into large ponds. Farmers have argued against this idea, because they are concerned that taking away too much of the grassy areas will hurt the sheep.

Prompt- Write a claim to counter the farmers' argument, using the data above. Make sure to include a rebuttal in your answer.

Scope #2: Flow of Matter and Energy in Ecosystems

- **Open-Ended Response Assessment:** 3 Questions

Scope #3: Animal Behavior and Survival

- **Claim-Evidence-Reasoning (CER):**

Scenario- Many fish live their entire lives with a school of other fish, while a Tasmanian devil lives alone, hunting for prey, such as fish.

Prompt- Write a scientific explanation about how individual and group behavior can affect the survival and reproduction of a species. Make sure to give clear examples in your reasoning.

End of Unit Assessment:

- 3D Interactive Assessment - Ecosystem Interactions and Energy

UNIT II: History of Earth's Atmosphere

Students will make links between photosynthesis and respiration in organisms and cycles of energy and matter in Earth systems. Students will create models to understand the molecules that form the basis of the living earth. They will discover how this knowledge can be applied to our world to connect the past, the present, and the future. **For a molecular focus**, students can emphasize the various energy, nutrient and resource cycles and the molecular mechanisms that allow life on earth to proliferate. Students will also learn a deeper understanding of the properties of chemical reactions. This foundational understanding will be needed in order to use a molecular lens to more deeply understand intracellular biochemical reactions.

Standards Addressed

HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

HS-LS1-6 Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

HS-LS1-7 Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

HS-LS2-3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

HS-LS2-5 Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

HS-ESS1-6 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.

HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Instructional Objectives

Students will be able to:

Students will make links between photosynthesis and respiration in organisms and cycles of energy and matter in Earth systems. Students will create models to understand the molecules that form the basis of the living earth. They will discover how this knowledge can be applied to our world to connect the past, the present, and the future. **For a molecular focus**, students can emphasize the various energy, nutrient and resource cycles and the molecular mechanisms that allow life on earth to proliferate. Students will also learn a deeper understanding of the properties of chemical reactions. This foundational understanding will be needed in order to use a molecular lens to more deeply understand intracellular biochemical reactions.

Suggested Activities

Scope 1: Cellular Energy and the Atmosphere

Assignment #1 Explore 1 - Inputs and Outputs: Cellular Energy
Students will model the chemical equations of photosynthesis and cellular respiration to see how energy and matter are transferred and flow from process to process. They will also explore which process stores and releases energy for use in organisms.

Assignment #2 Explore 2- Elodea and Cellular Energy Investigation
Students will conduct an investigation and will write a CER to explain that plants carry out photosynthesis and cellular respiration.

Assignment #3 Explore 3: Anaerobic Respiration Investigation
Students will design a lab to investigate which variable will produce the most energy in alcohol fermentation.

Scope 2: Carbon and the Earth

Assignment #1 Explore 1: The Carbon Cycle Game
Students model how a carbon atom moves through the carbon cycle. They will also create a storyboard to illustrate the journey their carbon atom took.
Assignment #2 Explore 3: Building Biomolecules
Students will model how lipids, proteins, and nucleic acids are formed from glucose and other substances from the surrounding environment. They will then write a scientific explanation that includes a claim, evidence, and reasoning (CER) to answer the question, "If you lived only on a diet of sugars, could you survive?

Scope 3: Interaction of Organisms and Earth's Systems

Assignment #1 Explore 1: Making Calcium Carbonate From Carbon Dioxide
Students model the formation of calcium carbonate and make the connection of how feedback systems affect the amount of carbon dioxide in the atmosphere, the amount of carbon available to marine organisms for shell construction, and the acidity of the ocean.
Assignment #2 Explore 2: Origin of Atmospheric Oxygen
Students research the origin of atmospheric oxygen and prepare a group poster that highlights the dynamic changes in our atmosphere from the formation of Earth through today. Afterward, students display posters for a gallery walk and share responses.

Additional hands-on activities/labs and interactive demonstrations for increased student engagement:

- **For a molecular focus** - Activity: A day in the food life.
- **For a molecular focus** - Laboratory investigation: Do All Active Living Things Give Off the Same Substance and if so, what is it?
- **For a molecular focus** - Laboratory investigation: How do matter transformations involve energy?
- Laboratory investigation (**HS-LS1-5)**: 1. How is CO2 involved with Plants? *A. Do plants use CO_2? B. Do they give off CO_2? C. Do they do both? D. What processes are going on in plants?* 2. Does it matter whether they are in the light or in the dark?
- Activity & reading (**HS-LS1-6):** Chemical Evolution
- Laboratory investigation for skills needed (Use of microscopes): Using a compound & dissecting microscope & measuring with compound microscopes.
- Laboratory investigation (**HS-LS2-3):** How did organisms on early Earth get energy from food?
- Demonstration for relationship between Cellular respiration and Photosynthesis (**HS-LS2-5)**: Ecosphere revisit (see Unit 1 for materials)

Suggested Assessments

Scope 1: Cellular Energy and the Atmosphere

1. **Claim Evidence Reasoning (CER)**

Prompt- A student is testing out different plant foods in the experiment above. Food A contains 70% glucose, while Food B contains 50% glucose. Based on the data, the student concluded that Food B was better, because the plant grew more. Was the student's conclusion accurate?

Scope 2: Carbon and the Earth

1. **Claim Evidence Reasoning (CER)**
   Prompt- The diagram shows how carbon is cycled through the environment. What two processes are most important in maintaining this cycle? Make sure your claim is supported with evidence and reasoning. Include a rebuttal in your response.
2. **Open-ended Response Assessment**

Scope 3: Interaction of Organisms and Earth's Systems

1. **Open-ended Response Assessment**

Additional assessments for increased student engagement:

- Short essay response: Biggest Loser Challenge question
- Formative assessment: Four corner activity - Biggest Loser
- Formative assessment: Four corner activity - Light and Dark (see How is CO2 involved with Plants? Lab)
- Short essay response: Sprout to tree Challenge question

End of Unit Assessment

Project Based Learning (PBL): All Systems Go!

UNIT III: Evidence of Evolution

Students will analyze the different types of evidence, such as rock layers, fossils, anatomical structures, DNA sequences and embryology, that scientists use to determine the common ancestry of different species. They will construct an explanation on the cause and effect relationship between natural selection and adaptation. Students will also compare and contrast the genetic and environmental conditions throughout Earth's history that leads to the creation or extinction of species. Students will learn about the environmental factors that can affect biodiversity. **For a molecular focus**, learning will emphasize molecular evolution (i.e. sequences of DNA/RNA, proteins)

Standards Addressed

HS-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

HS-LS4-2 Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Significant Connections to California's Environmental Principles and Concepts:

- Principle I: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.
- Principle II: The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.
- Principle III: Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.
- Principle V: Decisions affecting resources and natural systems are complex and involve many factors.

Instructional Objectives

Students will be able to:

Students will analyze the different types of evidence, such as rock layers, fossils, anatomical structures, DNA sequences and embryology, that scientists use to determine the common ancestry of different species. They will construct an explanation on the cause and effect relationship between natural selection and adaptation. Students will also compare and contrast the genetic and environmental conditions throughout Earth's history that leads to the creation or extinction of species. Students will learn about the environmental factors that can affect biodiversity. **For a molecular focus**, learning will emphasize molecular evolution (i.e. sequences of DNA/RNA, proteins)

Suggested Activities:

Scope 1: Evolution and Natural Selection

Assignment #1 Explore 1: Owl and Mouse. Differential survival activity. Students will roleplay a predator and hunt prey with different traits, collecting data about which traits become more common and which traits become less common over time.
Assignment #2 Explore 3: Environmental Influences and Natural Selection. Students will read about specific changes in a species and are asked to explain the environmental influences that led to those traits changing.

Scope 2: Evidence of Common Ancestry

Assignment #1 Explore 1 Fossil Formation: Students will explore how fossils form and the importance of fossils in determining common ancestry. Students will model fossil formation with a lab activity and compare the anatomical structures of extinct and living organisms.
Assignment #2 Explore 2 Evidence of Common Ancestry Stations: Students will visit various stations to analyze evidence of common ancestry such as including biogeography, anatomical, developmental, and molecular homologies.

Assignment #3 Explore 4 Evidence of Ancestry:: Students will research the different types of evidence used to explain an organism's evolutionary history and relatedness.

Scope 3: Biodiversity and the Environment

Assignment #1 Explore 1 Human Settlements: Students research the natural resources that influenced people to settle in certain areas, including some ancient cities and some of the largest cities in the United States.
Assignment #2 Explore 2 The Case of the Disappearing City Students will be given a scenario and data for a city that has suffered some loss of natural resources, change in climate, or natural hazards and will explain what happened to the city in terms of population size, distribution, and migration patterns. **Assignment #3 Math Connections -** Human Dependence on Earth: Students will be able to use basic mathematical and algebraic skills in order to evaluate a solution to a complex, real-world problem (water availability) based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Additional hands-on activities/labs and interactive demonstrations for increased student engagement:

- Case study analysis & class discussion (**HS-LS4-4 & HS-LS4-5**): Finches of the Galapagos islands
- Case study analysis & class discussion (**HS-LS4-4 & HS-LS4-5**): Peppered moths in England
- Case study analysis & class discussion (**HS-LS4-4 & HS-LS4-5**): Bacteria and antibiotic resistance
- Laboratory investigation (**HS-LS4-2): ** Is there variation within a species and if so, is there a pattern to the variation?
- Class activity (**HS-LS4-2)**: Oh deer!
- Lab activity (**HS-LS4-2): ** How might the variations that naturally exist within a population affect the survival of individuals?

Suggested Assessments
Scope 1- Natural Selection Assessment: Open Ended Response Students will explain how evolution and natural selection are linked, and what factors influence evolution

Scope 2- Evidence of Common Ancestry Assessment: Open Ended Response Students will explain how shared structures support common ancestry and interpret a simple phylogenetic tree

Scope 3- Biodiversity and the Environment Assessment: Claim Evidence Reasoning Students will make a claim about how natural hazards have shaped human history and migration using data.

End of Unit Assessment: Segment 3 Mission Statement: Building a Model - Students use information gathered in these activities to build a model for how the fossil

record forms and demonstrates evidence for evolution. They will use a claim-evidence-reasoning format to describe how their chosen fossil organism evolved and what common ancestors it shares with modern species.

Additional assessments for increased student engagement:

- Short essay response: Peppered moth explanation
- Card sort: Peppered moths
- Short essay response: Antibiotic resistant bacteria explanation
- Card sort: Antibiotic resistant bacteria

UNIT IV : Inheritance of Traits

Students develop explanations about the specific mechanisms that enable parents to pass traits on to their offspring. They make claims about which processes give rise to variation in deoxyribonucleic acid (DNA) codes and calculate the probability that offspring will inherit traits from their parents. Students will study the specific mechanisms that enable parents to pass traits on to their offspring and will discover how this knowledge can be applied to our world. **For a molecular focus,** learning should explore the role and implications of mutations in cellular DNA. Students should also learn the underlying foundation of gene expression using mendelian genetics in order to more fully

understand dominance, codominance, sex-linked inheritance, multiple alleles, and polygenic inheritance on a molecular level.

Standards Addressed

HS-LS3-1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

HS-LS3-2 Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

HS-LS4-2 Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-3 Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Instructional Objectives

Students will be able to:

Students develop explanations about the specific mechanisms that enable parents to pass traits on to their offspring. They make claims about which processes give rise to variation in deoxyribonucleic acid (DNA) codes and calculate the probability that offspring will inherit traits from their parents. Students will study the specific mechanisms that enable parents to pass traits on to their offspring and will discover how this knowledge can be applied to our world. **For a molecular focus,** learning should explore the role and implications of mutations in cellular DNA. Students should also learn the underlying foundation of gene expression using mendelian genetics in order to more fully

understand dominance, codominance, sex-linked inheritance, multiple alleles, and ploygenic inheritance on a molecular level.

Suggested Activities:

Scope #1: Inheritance of Traits

Assignment #1 - Explore 2: Gene Expression
Using an example of DNA, students will explore how gene expression dictates cell function and how expression can be influenced by environmental factors. Students will explain how genes are affected by environmental factors in different types of animals.
Assignment #2 - Elaborate: TUVA Data Literacy, Amylase Production (Part 1)
Students will use data collected by George Perry and his colleagues to test their hypothesis that production of amylase corresponds to the number of AMY1 gene copies and that a diet rich in starch can favor selection of individuals with increased capacity for producing amylase (i.e., more AMY1 gene copies).

Scope #2: Variations in Traits

Assignment #1 - Explore 1: Gamete Formation
Students will determine the relationship between parent cells and gametes by modeling how gametes have a reduced number of chromosomes.
Assignment #2 - Explore 2: The Big Mix-Up During Meiosis
Students will model how meiosis leads to new genetic combinations and increased genetic variation through crossing-over.
Assignment #3 - Math Connections: Variation in Traits
The students will create a Punnett square to figure out the genotype and phenotype of offspring and will calculate the genotypic and phenotypic ratios from the chart.

Scope #3: Natural Selection and Traits

Assignment #1 - Explore 1: Genetic Variation
Students will examine the process of natural selection by analyzing the peppered moth populations before and after the Industrial Revolution in England. **Assignment #2 - Explore 2: Sickle Cell and Malaria**
In this investigation, students will explore how natural selection can change the allele frequencies of the distribution of the sickle cell trait in humans. Students will complete the investigation by analyzing how mutations such as the sickle cell mutation may contribute to evolution.
Assignment #3 - TUVA: Data Literacy - World Wildlife Populations
Students manipulate the TUVA data graphs to visualize the effect of natural selection on populations of wildlife around the world.

Additional hands-on activities/labs and interactive demonstrations for increased student engagement:

- **For a molecular focus -** case study: Model families
- **For a molecular focus -** Genetics problems sets

- **For a molecular focus -** individual or small group lab activity: Variations of the human face
- Individual or small group activity (HS-LS3-2): Meiosis kits
- Individual or small group activity (HS-LS3-2): Cross over activity
- Laboratory investigation (HS-LS3-3): Investigating the laws of probability
- Laboratory investigation (HS-LS3-3):Can the frequency of alleles in a gene pool be used to predict the chances of a particular genotype occurring? How does a gene pool behave from one generation to the next?
- Laboratory investigation (HS-LS3-3, HS-LS4-3, HS-LS4-4):What happens in a gene pool if all phenotypes do not have an equal chance of surviving? How does it affect the species?

Suggested Assessment

Scope #1: Inheritance of Traits

- **Open-Ended Response Assessment:** 3 Questions

Scope #2: Variation in Traits

- **Open-Ended Response Assessment:** 3 Questions

Scope #3: Natural Selection and Traits

- **Claim-Evidence-Reasoning (CER)**

Peter and Rosemary Grant finch data scenario for beak depth and rainfall

End of Unit Assessment:

- 3D Interactive Assessment - Inheritance of Traits

Additional assessments for increased student engagement:

- Short essay response: Twins explanation
- Short essay response: The McCann family (blood type inheritance)

UNIT V: Structure, Function and Growth

Students use models to create explanations of how cells use DNA to construct proteins, build biomass, reproduce, and create complex multicellular organisms. Students will be able to differentiate between DNA, genes and chromosomes and how each functions in an organism. Students will investigate cellular division, and how organisms maintain homeostasis through feedback systems. **For a molecular focus**, students place emphasis on the molecular process of protein synthesis (transcription and translation), cellular division, differentiation and feedback mechanisms. Students might also look closely at the properties of proteins and role in the proliferation of life. Students will discover how epigenetic changes can turn the expression of genes "on" or "off," the environmental factors that might influence epigenetics, and how epigenetic changes can be inherited from previous generations.

Standards Addressed:

HS-LS1-1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

Instructional Objectives

Students will be able to:

Students use models to create explanations of how cells use DNA to construct proteins, build biomass, reproduce, and create complex multicellular organisms. Students will be able to differentiate between DNA, genes and chromosomes and how each functions in an organism. Students will investigate cellular division, and how organisms maintain homeostasis through feedback systems. **For a molecular focus**, students place emphasis on the molecular process of protein synthesis (transcription and translation), cellular division, differentiation and feedback mechanisms. Students might also look closely at the properties of proteins and role in the proliferation of life. Students will discover how epigenetic changes can turn the expression of genes "on" or "off," the environmental factors that might influence epigenetics, and how epigenetic changes can be inherited from previous generations.

Suggested Activities

Scope #1: Cell Division and Complex Organisms

Assignment #1 Engage: Accessing Prior Knowledge
Students will use a copy of cell division to differentiate between Meiosis and Mitosis using a Venn diagram.
Assignment #2 Explore: When is the Cell Dividing? Students will construct a line graph of the amount of DNA during the cell cycle. Next, using the graph they constructed, they will draw a comic strip illustrating what happens to a cell during the cell cycle. Then, they will write a scientific explanation that includes a claim, evidence, and reasoning (CER) to answer the question, “Which frame of your comic strip represents the cell dividing?

Scope #2: DNA to Proteins:

Assignment #1 Explore 1: Components of DNA.
Students will construct a model of DNA using puzzle pieces and will identify the various components (sugar backbone, nucleotides (nitrogenous base pairs), phosphate group, and hydrogen bonds.
Assignment #2 Explore 2: Make Me a Sandwich.
Students will do an activity using the metaphor of sending a friend out to get a sandwich and relate it to how RNA codes and builds proteins.

Scope #3: Systems and Homeostasis

Assignment #1 Explore 1: 3-D Body System.
Students will create a 3-D model of an organ system. This model will allow for the development and organization of the organ system from the macroscopic to the microscopic level, including structure and function.
Assignment #2 Explore 4: Homeostasis in Plants.
Students will use inquiry to investigate homeostasis in plants. They will design, plan and carry out an investigation with guidance from the instructor.

Additional hands-on activities/labs and interactive demonstrations for increased student engagement:

- Individual or small group activity (HS-LS1-1): DNA kits
- Group activity (HS-LS1-3): "I workout" heart rate activity.
- Laboratory investigation (HS-LS1-2): How do cells from different organisms compare in their structures? How are their structures related to their functions?
- Laboratory investigation (HS-LS1-2, HS-LS1-4): What happens to pieces of cut up planaria?
- Laboratory investigation (HS-LS1-2, HS-LS1-4): How do Japanese Medaka reproduce and develop? What strategies enable the species to be successful?
- **For a molecular focus -** Laboratory investigation: What Determines a Plant's Ability to Produce Chlorophyll?
- **For a molecular focus -** Laboratory investigation: What do Living Cells Contain that Makes it Possible for the Chemical Activities of Life to Occur at Moderate Temperatures?

Suggested Assessment
Scope #1: Cell Division and Complex Organisms
Claim Evidence Reasoning (CER)
Students look at the data and write a claim as to how the changes illustrated above occur. Students should write a CER that begins with a claim like The original cell in this illustration goes through mitosis to create two identical daughter cells that, along with genetic instructions, differentiate into different specialized cells.

Scope #2: DNA to Proteins
Open ended Response: 3 questions

Scope #3: Systems and Homeostasis

Claim Evidence Reasoning
Students will look at two different scenarios and write a scientific explanation for each; explaining what the body needs to regulate to reach homeostasis.

End of Unit Assessment
Students use models to create explanations of how cells use DNA to construct proteins, build biomass, reproduce, and create complex multicellular organisms. They investigate how these organisms maintain stability.

Additional assessment for increased student engagement:

- Card sort: Protein Synthesis

UNIT VI: Ecosystem Stability & the Response to Climate Change

Students use computer models to investigate how Earth's systems respond to changes, including climate change. Students will analyze the effects that human activities have on the environment and biodiversity. They make specific forecasts and design solutions to mitigate the impacts of these changes on the biosphere. **For a molecular focus**, students will be given the opportunity to explore the impacts of climate change at a molecular scale. Learning will extend conceptual models to include more molecular characteristics and features of climate.

Standards Addressed

HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Significant Connections to California's Environmental Principles and Concepts:

- Principle I: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.
- Principle II: The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.
- Principle III: Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.
- Principle V: Decisions affecting resources and natural systems are complex and involve many factors.

Instructional Objectives

Students will be able to:

Students use computer models to investigate how Earth's systems respond to changes, including climate change. Students will analyze the effects that human activities have on the environment and biodiversity. They make specific forecasts and design solutions to mitigate the impacts of these changes on the biosphere. **For a molecular focus**, students will be given the opportunity to explore the impacts of climate change at a molecular scale. Learning will extend conceptual models to include more molecular characteristics and features of climate.

Suggested Activities

Scope 1: Human Impacts on Ecosystems

Assignment #1 Explore 1: Are We Destroying the Planet?
Students will be exploring ways humans are impacting Earth. They will create a PSA to share with the class.

Assignment #2 Explore 4: Modeling the Spheres
Working in pairs, students will use computer simulations to create a computational model of the effect of human-generated carbon dioxide on the relationships between Earth systems. Using mathematical representations, students will communicate the effects of melting permafrost, new vegetative growth, wildfires, and human emissions have on the Earth. The models and mathematical representations will be used to predict changes in Earth's global climate.

Assignment #3 Explore 5: Factors Affecting Biodiversity:

Students will research an assigned ecosystem to determine which factors affect biodiversity the greatest. They will gather and synthesize their research onto a poster board to then present in a gallery walk and take a stance about which factor has the greatest impact on a global scale.

Scope 2: Climate and Ecosystems

Assignment #1 Explore 1: My Climate Forecast

Students will research a chosen topic: greenhouse gases, weather and climate, oceans, snow and ice. They will summarize the geoscience data provided on the website to make predictions about our climate in the next 20 to 100 years. They will compare their predictions with other groups who researched the same topic and have a discourse with guidance from the instructor.

Assignment #2 Explore 2: Population Dynamics

In this activity, students will be given a scenario (addition of a new species to a community in an ecosystem), and asked to respond with a CER. Students will then be given a data set to evaluate. Using this data, students will then readdress the initial CER.

Assignment #3 Explore 4: What Does the Data Say?

Students will be presented with various types of data about the bee-colony population. They will analyze and interpret the data to make a claim about the causes of the population decline. Students will support their claim with the evidence that they have been provided. Students will share their claim and listen to the claim of other groups in order to make revisions.

Additional hands-on activities/labs and interactive demonstrations for increased student engagement:

- Small group act**ivity (**HS-LS2-7, HS-LS4-6)**: Biodiversity Jenga**
- Individual or small group project (HS-LS2-6, HS-LS2-7, HS-LS4-5, HS-LS4-6): **Extinction project**

Suggested Assessment

Scope 1: Human Impacts on Ecosystem

Claim Evidence Reasoning essay about the impacts of farmland and how to mitigate its impact on biodiversity.

Scope 2: Climate and Ecosystems

Open ended response Assessment: 3 questions

End of Unit Assessment

3-D Interactive Assessment: Ecosystem Stability and the Response to Climate Change.

Additional assessment for increased student engagement:

- **Extinction project (see above)**

Sacramento City Unified School District

COURSE OF STUDY

FOR

Honors Chemistry in the Earth System
QCS310, QCS311

Segment	High School
Length of Course	One Year
Developed by	*SCUSD Teacher Committee* *Aaron Pecho, Science Coordinator* *Janna Cantwell, Training Specialist*
First Edition	Fall 2020

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

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HONORS CHEMISTRY IN THE EARTH SYSTEM

SECTION ONE — GENERAL INFORMATION

COURSE DESCRIPTION

Chemistry in the Earth System is a two semester, lab-based course that addresses the Next Generation Science Standards and is guided by the California Science Framework's High School 3-Course Model. It is a hands-on, inquiry based course, where students will explore chemical and earth science concepts through rigorous investigations. The chemical and earth science performance expectations are taught in an integrated manner to help students build deeper comprehension and correlate how chemical processes and Earth processes are interdependent. This course starts with an introductory segment on lab safety, followed by five instructional segments that are each centered around a real world phenomenon. Students learn by asking and answering essential questions about these phenomena. Concepts build on each other and are revisited throughout the course to build a deeper understanding of chemistry and earth processes.

This course is designed as an alternative course to be taken in lieu of Chemistry in the Earth System. Lessons go deeper into the content, and ask students to analyze data and explain phenomena more independently and on a deeper level. Students learn by "doing chemistry" by developing questions and seeking answers through open-ended lab investigations, observations, and data analysis. Students are challenged to think abstractly while learning the Next Generation Science Standards. Students more fully develop their critical thinking, writing, and communication skills as they produce formal, written reports and collaborate in lab groups. This course will include a comprehensive final examination at the end of each semester and/or a substantive, culminating project. The purpose of the final exam/project is for students to exhibit depth of knowledge and sustained mastery of subject material.

This course meets the SCUSD high school graduation requirement for physical science and counts as a University of California A-G Lab Science course.It also gives students the opportunity to earn honors credit for their GPA on their high school transcript.

RATIONALE

Science is a continuing search for the truth in our highly developed and technologically advanced society. Any living organism must be considered to be a complex chemical system and part of our environment. To understand how life affects and is affected by our physical environment (the earth and its systems), we must have a basic understanding of Chemistry. Additionally, this course offers college preparatory students a more thorough treatment of many of the concepts taught in the non-honors chemistry/earth course and a more thorough application of the science and engineering practices associated with NGSS, as well as the opportunity to address additional topics not covered in that course.

COURSE GOALS

Upon completion of this course, students will be able to demonstrate mastery of the relevant Next Generation Science Standards and an increased depth of understanding of fundamentals and a reasonable competence in dealing with chemical problems. The course will contribute to the development of the students' abilities to think clearly and to express their ideas, orally and in writing, with clarity and logic.

COURSE STANDARDS

UNIT 1 - SEGMENT 1: COMBUSTION, HEAT AND ENERGY IN THE EARTH SYSTEM

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

HS-PS3-2. Develop and use 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 position of particles (objects).

HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

UNIT 2 - SEGMENT 2: ATOMS, ELEMENTS, AND MOLECULES

HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

UNIT 3 - SEGMENT 3: CHEMICAL REACTIONS

HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

UNIT 4 - SEGMENT 4: CHEMISTRY OF CLIMATE CHANGE

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios *

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity

UNIT 5 - SEGMENT 5: THE DYNAMICS OF CHEMICAL REACTIONS AND OCEAN ACIDIFICATION

HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium *.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere

The science and engineering practices are what students DO to make sense of phenomena. They are both a set of skills and a set of knowledge to be internalized. These practices reflect the major practices that scientists and engineers use to investigate the world and design and build systems. They are to be used within each learning segment in order to ensure students can apply the chemistry content. The practices are summarized below.

- **Asking questions and defining problems** in 9–12 builds on grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

- **Developing and Using Models** in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
- **Planning and carrying out investigations** in 9-12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
- **Analyzing and interpreting data** in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
- **Using Mathematics and computational thinking** in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
- **Constructing explanations and designing solutions** in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
- **Engaging in argument from evidence** in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
- **Obtaining, evaluating, and communicating information** in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims,

INSTRUCTIONAL MATERIALS

Moore, Christopher, Wysession, Michael, Lutes, Bryn. *Experience Chemistry in the Earth System*. Boston, MA; Pearson. 2021.

SUGGESTED AVERAGE TIME FOR COVERING MAJOR UNITS

- UNIT 0: CHEMICAL SAFETY (~4 class periods*)
- UNIT 1 - SEGMENT 1: COMBUSTION and HEAT AND ENERGY IN THE EARTH SYSTEM (~23 class periods total)
- UNIT 2 - SEGMENT 2: ATOMS, ELEMENTS, AND MOLECULES (~33 class periods)
- UNIT 3 - SEGMENT 3: CHEMICAL REACTIONS (~54 class periods)
- UNIT 4 - SEGMENT 4: CHEMISTRY OF CLIMATE CHANGE (~32 class periods)
- UNIT 5 - SEGMENT 5: THE DYNAMICS OF CHEMICAL REACTIONS AND OCEAN ACIDIFICATION (~32 class periods)

* *Assuming 178 class periods of 55 minutes each class.*

TEACHER RESOURCES

Teacher guide for *Chemistry in the Earth System Volume 1 (covers Instructional Segments 1,2, and 3)*. *Volume 2 (covers Instructional Segments 4 and 5)*

California Science Safety Handbook

English Language Development Standards NGSS Correlation (pages T98-T105)
FLINN SCIENTIFIC (HTTPS://WWW.FLINNSCI.COM/)
https://thewonderofscience.com/
California Education and Environment Initiative Science Curriculum Bank - "E" Units
California Department of Education NGSS Resources and Instructional Materials
CA Science Framework Description (Chemistry in the Earth System)

California Science Framework Chapter 7 Chemistry in the Earth System

Brown, Theodore L., et al. *Chemistry: The Central Science.* 14th edition, AP© edition. Pearson. New York, NY. 2018. (*AP© is a registered trademark of the College Board, which was not involved in the production of, and does not endorse, this product.*)

Tro, Nivaldo J. *Chemistry: A Molecular Approach.* 5th edition. Pearson. USA. 2020.

RECOMMENDED STUDENT RESOURCES
BOZEMAN SCIENCE (HTTP://WWW.BOZEMANSCIENCE.COM/)
BRIGHTSTORM SCIENCE (HTTPS://WWW.BRIGHTSTORM.COM/SCIENCE/CHEMISTRY/)
CRASH COURSE CHEMISTRY
(HTTPS://WWW.YOUTUBE.COM/PLAYLIST?LIST=PL8DPUUALJXTPHZZYUWY6FYEAX9MQQ8OGR)
FLINN SCIENTIFIC (HTTPS://WWW.FLINNSCI.COM/)
ISAACS TEACH (HTTPS://WWW.YOUTUBE.COM/USER/ISAACSTEACH)
PHET SIMULATIONS: HTTPS://PHET.COLORADO.EDU/

SECTION TWO — COURSE UNITS

UNIT 0: Safety in the chemical laboratory

The students enrolled in this course will, by necessity, be handling dangerous chemicals as they conduct the various laboratory activities/experiments in this course. It is necessary that all safety precautions involved in using such chemicals be observed. It is essential, therefore, that the class size not exceed the number of laboratory stations available to the students. Each laboratory must be equipped with a proper fire extinguisher; fire blankets, safety shower, and eye wash stations. Each laboratory must have a fume hood and be so ventilated that the students will not be exposed to noxious gases that are generated in some of the laboratory experiments. All students should be equipped with OSHA approved eye protection, aprons and gloves when necessary for the various experiments. Each laboratory classroom should have a goggle sterilization cabinet to sterilize goggles in between class periods of students.

Teachers should be cautious not to exceed the suggested capacity of the room if laboratory activities are to be a regular part of the science courses to be taught there. Should overcrowding result from errors in scheduling, or due to administrative oversight, it is important that the teacher notify the principal, in writing, of the safety hazard that has been created. If the room is seriously overcrowded, the teacher should suspend laboratory activities until the problem has been corrected.

Additional recommendations with regards to laboratory safety:

1. All facilities should conform to federal, state, and local laws and guidelines as they pertain to the safety of students and instructors. Instructors should consult the California Science Safety Handbook for any questions regarding safety.

2. Chemistry students should not carry out laboratory experiments and demonstrations if they could expose the students to risks or hazards that are inappropriate for learning in the instructional sequence (e.g., explosion experiments that do not have any learning objective).

3. Students should be fully informed of potential laboratory hazards relating to chemicals and apparatus before performing specific experiments. Students themselves should research needed safety information in advance by using an SDS (Safety Data Sheet) database (*FLINNSCI.COM/SDS).* A hard copy of all SDS should be kept in the classroom for student and instructor use. SDS health and safety information should be a mandatory part of each student's lab write-up.

4. Storage and disposal of hazardous chemicals must always be done in accordance with local regulations and policies. As far as possible, the students as well as the instructor should know what these regulations are. An annual chemical inventory should be completed by the chemistry instructors at each site; a copy of which should be provided to the plant manager, the science department, school administration, and the district safety/chemical hygiene officer. The district and site chemical hygiene officer should keep in regular contact with all classroom chemistry instructors to keep them abreast of hazardous chemical pick-up and disposal *information.*

A successful Chemistry laboratory program will instill in each student a true, lifelong "safety sense" that will ensure their safe transition into more advanced laboratory work in college or university laboratories or into the industrial workplace environment.

Students will be knowledgeable about and be able to carry out the following safety procedures:

- simple first aid for cuts, thermal and chemical burns;
- use of safety goggles, eye washes, safety showers, fire blankets, and fire extinguishers;
- safe handling of glassware, hot plates, burners and other heating devices, and electrical equipment;
- proper interpretation of SDS and hazard warning labels; and
- proper use and reuse practices (including proper labeling of interim containers) for reagent bottles.

Standards addressed

The American Chemical Society
https://www.acs.org/content/acs/en/education/policies/safety.html

- Chemical Safety for Teachers and Their Supervisors

- Guidelines and Recommendations for the Teaching of High School Chemistry
- Chemical Health & Safety Resources

California Science Safety Handbook

OSHA: https://www.osha.gov/laws-regs/regulations/standardnumber

Instructional Objectives
Students will be able to determine which safety procedures are relevant for each laboratory activity and successfully implement their use to maintain the health and safety of themselves, their peers and their instructor.

Suggested Activities
- Safety lab - rotating stations demonstrating various safety techniques, procedures and "dangers"
- Students and their parents/guardians will be required to sign a safety contract before being allowed to participate in laboratory activities.
- Watch safety videos: Pearson Realize has a series of 8 Flinn safety videos provided in the Lab Resource Center available online.
  1. Introduction to Laboratory Safety
  2. Prelab Safety
  3. Safety equipment
  4. Personal Protective Equipment
  5. Chemical Labels and Safety Data Sheets
  6. Responsible Chemical Disposal
  7. Common Lab Procedures
  8. Exposure Response

Flinn Scientific Safety video for physical sciences is available on youtube:
https://www.youtube.com/watch?v=HLaOJKD9iDg&t=187s

A"fun" safety video is "The Accident at Jefferson High" (18:28) available on youtube.
https://youtu.be/S0QnsJV2d3E

Other safety videos made by Flinn scientific are available at this link:
https://www.youtube.com/results?search_query=flinn+scientific+safety+video

Teachers should visit https://labsafety.flinnsci.com/ and create an account to be able to access safety contracts, safety tests and other safety reference materials.

To accommodate students with disabilities please refer to state, local and district guidelines. A useful reference is *Teaching Chemistry to Students with Disabilities* Thomas J. Kucera; Editor published by the American Chemical Society. August 1993 (3rd edition). ISBN 0-8412-2734-9

Suggested Assessment

Students will be required to take a laboratory safety test. Students should be given the opportunity to retake the test as many times as necessary to achieve a perfect score; safety is not optional. The assessment should also include a “map of the laboratory classroom” requiring students to pinpoint the location of all safety equipment to include eye washes, safety showers, goggle sterilization cabinet(s), safety blanket, first aid kit, fire extinguisher(s), chemical waste containers and all exits.

UNIT 1 - Segment 1: Combustion, Heat, and Energy in the Earth System

In this instructional segment, students are introduced to the concept of energy as it relates to chemistry and earth science. They explore energy in its different forms, how it can be measured and how it can be converted from one form to another. They investigate combustion reactions, geothermal energy as a way to produce electricity and heat transfer as it relates to processes at work in the earth's atmosphere, surface and interior.

Standards Addressed

HS-PS1-3
HS-PS1-4
HS-PS1-7
HS-PS3-1
HS-PS3-2
HS-PS3-4
HS-ETS1-4
HS-ESS2-3

Instructional Objectives

Students will be able to answer the following **essential questions** via the corresponding *competencies*:

Why are wildfires so difficult to extinguish?

1. *Students will identify factors that sustain a combustion reaction.*
2. *Students will identify products of combustion reactions and how mass is conserved even when it does not appear to be.*
3. *Students will draw connections between wildfires and natural gas fires.*
4. *Students will make a connection between the chemical energy stored in fuel and in food.*

How does California get electricity from geothermal energy?

5. *Students will identify the various forms that energy can take including kinetic, potential, chemical, thermal, electromagnetic, electrical and mechanical.*
6. *Students will describe the sequence of energy transformations that take place as thermal energy into electrical energy*

Why are there so many volcanoes in California?

7. *Students will use the principles of plate tectonics and understanding of the layers of the Earth's interior to explain the phenomena of volcanoes.*
8. *Students will identify and describe methods of heat transfer including conduction, convection and radiation*

Suggested Activities

For the purposes of designating useful information about the assignments, a coded label system is used. This system will be used throughout all of the different units.
[+] - This activity is designated by the Pearson teacher's manual as an additional, more in depth, optional assignment. ***For Honors Chemistry as many of these additional activities that can be incorporated into the course should be.***
[★]- This activity is part of the core experiences set of labs kit or the performance assessments kit where Flinn lab materials are provided by the district.
[#] - This activity is not provided as part of the core experiences but utilizes materials that are commonly found or easily accessible in most chemistry lab classrooms.

Some labs have specific information pertaining to teaching students with special needs, struggling students, ELD students, and advanced students. These will be noted with the following numbers:
[1] - This activity provides support for teaching students with special needs.
[2] - This activity provides support for teaching students who are struggling.
[3] - This activity provides support for teaching students who are advanced.
[4] - This activity provides support for teaching students who are developing their English skills.

Key Assignments may include:

Problem Based Learning/Web Research

- Coal Fire at the Seam **+**

Authentic Readings/Worksheets

- Learn More About Wildfires Reading/Learn More About Wildfires Worksheet **+**
- Supercharged geothermal energy could power the planet/Worksheet **+**

Labs

For all Honors Chemistry students it is recommended that all lab activities from Pearson/Savvas Realize be used in their open-ended or advanced inquiry versions.

- Energy Densities of Organic Fuels ★
- Measure Energy Flow in Chemical Reactions ★
- Matter Transformation in Combustion **#**
- Introduction to Electromagnetism
- Thermal Energy and Heat Transfer ★,**[4]**
- Evaluate the Thermal Equilibrium of Metals **#**
- Observe Convection Currents #
- Rise and Fall of Pangaea ★

Computer Simulations

- Virtual Lab: Conservation of Mass During Combustion **+**
- Virtual Lab: Measuring Energy in Food **+**
- PhET Interactive Simulation: Energy Forms and Changes
- Virtual Lab: Measuring Heat Conduction **+**

Analyzing Data

- Analyze Food Labels for Energy Content **+**
- Pendulums and the Conservations of Energy **+,[2],[3]**
- Assess California's Energy Supply **+,[2],[3]**
- Compare the Efficiency of Light Bulbs **+**
- Compare Heat Capacities **+,[2],[3],[4]**
- Evidence from Earthquakes **[2],[3]**
- Tracking Plate Movement **+**

Modeling Activities

- Model Chemical Potential Energy **[4]**
- Model Examples of Energy Flow **[4]**
- Model Energy Transfer and Conservation (Geysers)
- Modeling Energy in Different Forms **[1],[2]**
- Model Environmental Convection
- Convection in the Mantle **[2],[3],[4]**

Engineering Design Challenge

- Energy Efficient Cookware **+,[4]**
- Conservation of Mass in Chemical Reactions **+**
- Build a Basic Generator **+**

CERs

- Discuss Changes in a Burning Log **[1],[3]**
- How to Boil Water
- Pitch Drop Experiment **[2],[3],[4]**

Writing About Science/Other Activities

- Physical Properties as Design Criteria **+**
- Modes of Heat Transfer
- Why do rocks melt under the ocean? **[1],[2],[3]**

Suggested Assessments

- 3D Assessment: Combustion-Matter, Energy, and Change
- Performance Based Assessment - Measuring the Energy in Combustion Reactions ★,[2],[3]
- 3D Assessment: Energy Transfer and Conservation
- Performance Based Assessment - Electricity and Wind Energy ★,[1],[3]
- 3D Assessment: Earth's Interior
- Performance Based Assessment - Investigate the Rock Cycle ★,[1],[2],[3]
- Pencil and paper teacher generated assessments

UNIT 2 - Segment 2: Atoms, Elements and Molecules

In this instructional segment, students explore electron energy levels, atomic orbitals, and electron configurations. They discover patterns in the periodic table and connect that to properties of the elements in the table. Students investigate different types of chemical bonds. They explore intermolecular forces and attractions between molecules.

Standards Addressed
HS-PS1-1
HS-PS1-2
HS-PS1-3
HS-PS1-7
HS-PS2-4
HS-PS3-5

Instructional Objectives
Students will be able to answer the following **essential questions** via the corresponding *competencies*:

What causes the colors in a fireworks display?

1. Students relate the properties of atoms to the differences in mineral properties, and the atomic emission spectra of elements to light emitted by fireworks.

Why are elements in pure form so rare?

2. *Students explain periodic trends of elements in relation to the differences in minerals.*

Why do gems have different properties than metals?

3. *Students explain how differences in bonding produce differences in properties of gems and metals and apply the knowledge to explain how minerals are distinguished from one another.*

Suggested Activities
Key Assignments may include:

Problem Based Learning/We Research

- Minerals, Crystals and Gemstones **+,[1],[2]**

Authentic Readings/Worksheets

- Firework Color Chemistry
- Meet 115: THe Newest Element on the Periodic Table **+**

Labs

- Flame Lab
- Bean Bag Isotopes
- Evaluate Atomic Spectra (Atomic Spectra Lab)
- Evaluate the Bohr model of the atom
- Model Electron Configuration★
- Develop a Periodic Table★
- Elements, Metals, Nonmetals and Metalloids
- Periodic Trends and Properties **[1],[3]**

- Characteristics of Ionic Bonds★,**[4]**
- Investigate Metallic Bonds
- Investigate Covalent Bonds★
- Intermolecular Forces
- Chemical Names and Formulas★
- Dehydrate Copper Sulfate Pentahydrate
- Comparing and contrasting mineral families (gem variations)

Computer Simulations

- Build an Atom - PhET Simulation
- Isotopes and Atomic Mass - PhET Simulation
- Rutherford Scattering - PhET Simulation
- The Quantum Mechanical Model and Atomic Orbitals **+**
- Ions and Electroplating +
- Predict Reactivity Using Periodic Trends **+,[2],[3]**
- Coulomb's Law - PhET Simulation
- Molecule Polarity - PhET Simulation
- Molecule Shapes - PhET Simulation
- Intermolecular Forces in Liquids **+**
- Atomic Interactions - PhET Simulation

Analyzing Data

- Explore Atomic Particles **+**
- Intensive and Extensive Properties **+**
- Explore Bohr Model Patterns **+**
- Patterns in Electron Configurations **+**
- Graphing Periodic Properties **+,[1],[4]**
- Size, Trends and Shielding Effect **+,[2],[3]**
- Patterns in Melting Points of Metals **+**
- Calculate Bond Polarity **+**
- Investigate Molecule Polarity **+,[2],[3]**
- Infer Rules for Naming Compounds **+,[1],[2]**
- Infer Rules for Naming Acids **+**

Modeling Activities

- Model Isotopes **[2],[3],[4]**
- Modeling Atomic Structure
- Modeling Electron Configurations **[1],[2]**
- Electron Dot Structures for Ionic Compounds **[2],[3]**
- Electron Dot Structures for Molecular Substances

Engineering Design Challenge

- Build a spectroscope from household materials **+,[1]**
- Growing Crystals in Gels **+,[1],[2]**
- Evaluate Metals for a Commercial Application **+, [1],[2],[3]**

CERs

- Emission Spectra of Elements **[2],[3],[4]**
- The Periodic Table
- Evaluate Atomic Models **[1],[3]**
- Periodic Trends **[1],[2],[3]**
- Electron Configuration and Element Properties **[2],[3],[4]**
- Effective Nuclear Charge and Electron Shielding **[4]**
- Chemical Bonding
- Compare Metallic and Ionic Substances **[1],[2],[3],[4]**
- Compare Molecular Compound Properties **[1],[3],[4]**
- Comparing Compound Nomenclatures

Writing about Science/Other Activities

- The History of Atomic Models **+**
- Properties of Atoms: Size vs Mass **+**
- Reflect on Periodic Trends **+**
- Describe Ionic Bonding and Properties **+**
- Water's Behavior on Earth **+,[2],[3]**

Suggested Assessments

- 3D Assessment Atomic Spectra
- *Performance Based Assessment Evaluate Atomic Structure with Flame Tests* ★,[1]
- 3D Assessment The Periodic Table
- *Performance Based Assessment Gravimetric Analysis of Periodic Trends* ★,+,[1],[3]
- 3D Assessment Chemical Bonding
- *Performance Based Assessment Qualitative Analysis and Chemical Bonding* ★,[3]
- Pencil and paper teacher generated assessments

UNIT 3 - Segment 3: Understanding Chemical Reactions

In this instructional segment, students explore states of matter and phase changes. They investigate molar relationships and calculate percent composition of compounds. Students analyze different types of chemical reactions as they balance chemical equations. They complete chemical calculations on moles, mass, and volume. They explore energy in chemical bonds and analyze enthalpy in changes of state.

Standards Addressed

HS-PS1-2
HS-PS1-3
HS-PS1-4
HS-PS1-5
HS-PS1-7
HS-PS2-4
HS-PS3-5

Instructional Objectives

Students will be able to answer the following **essential questions** via the corresponding *competencies*:

How do we design materials for a specific function?

1. *Students identify properties of different states of matter and use this to better produce materials and foods.*

Why do we quantify matter in different ways?

2. *Students use their knowledge of molar and mass relationships to explain how to quantify different types of matter and to apply these calculations to producing better foods.*

How is energy obtained from chemical reactions?

3. *Students explain how energy is obtained from chemical reactions using knowledge of the different types of reactions. They apply this knowledge while explaining chemical reactions in food and how to produce better foods.*

What can make a recipe fail?

4. *Students apply knowledge of limiting and excess reagents to explain why a recipe fails. They also explain limiting and excess ingredients in foods.*

Why do you get hot when you exercise?

5. *Students use knowledge of system enthalpy to explain why we get hot when we exercise. They further apply this to enthalpy of foods and how to change it.*

Suggested Activities

Problem Based Learning/We Research

- The Chemistry of cooking and the properties of baked goods **+**

Authentic Readings/Worksheets

- Charging Ahead the Future of Batteries **+**
- Antarctica's Blood Red Waterfall **+**

Labs

- Correlate Material Properties and Bond Type
- Measure the Energy of a Phase Change ★
- Melt Ionic and Covalent Compounds ★
- Modeling Metals, Ceramics and Polymers
- Investigate Surface Tension
- Aqueous Solutions ★
- Describe Small Scale Matter Using the Mole ★
- Mole Ratios ★
- Determine an Empirical Formula ★
- Preparation of Solutions
- Evaluate Chemical Reactions ★
- Types of Chemical Reactions ★
- Predict Chemical Reactions **[1]**
- Identify Unknowns Through Stoichiometry
- Determination of Reaction Output ★
- Formation of Barium Iodate
- The Thermodynamics of Hand warmers ★,[2],[3]
- Hess's Law and the Combustion of Metal ★,[3]
- The Heat of Melting Ice

Computer Simulations

- States of Matter **+**
- States of Matter Basics – PhET Simulation
- Tough Tools **+**
- Mole Road Map **+**
- Making Dilutions **+**
- Concentrations – PhET Simulation
- Molarity – PhET Simulation
- Reactivity of Metals **+**
- Cation Meets Anion **+**
- Balancing Chemical Equations – PhET Simulation
- Limiting Reagent **+**
- Reactants, Products and Leftovers - PhET Simulation
- Temperature Changes in Chemical Reactions **+**
- Heat of Fusion **+**

Analyzing Data

- Analyze Phase Diagrams **+**
- Phase Change Graphs **+**
- Metals and Nonmetals: Data about their properties **+**
- The Density of Freezing Salt Water **+**

- Compare Intermolecular Forces in Fresh and Salt Water **+**
- Counting Atoms in One Gram **+**
- Identify an Element from its Molar Mass **+**
- Assess the Percent Composition in DNA **+**
- Solubility and Percent by Mass **+,[1],[2],[3]**
- Analyzing Chemical Reactions **+**
- Balancing Combustion Equations **+**
- Proportional Relationships in Chemical Reactions **+,[1],[2],[3]**
- Energy in Reactions +

Modeling Activities

- Phase Changes and Intermolecular Forces **[4]**
- Surface Tension and Polarity **[1],[2],[3]**
- Chemical Quantities
- Model Concentration's Effect on Conductivity **[1],[2],[3]**
- Model Molar Mass and Molar Volume **[1],[2],[3]**
- Model Percent Composition
- Model Measures of Concentration
- Chemical Reactions
- Modeling Chemical Reactions
- Thermochemistry
- Put it Together
- Chose a Practical Unit
- Energy Changes in Chemical Reactions
- Enthalpy Diagrams for Phase Changes **[2]**

Engineering Design Challenge

- Abrasive Compounds **+**
- Building a Better Bike **+**
- An Empirical Formula Challenge **+**
- Water Purification **+**
- Build a Film Canister Rocket **+**
- Flameless Heating Systems **+**

CERs

- Physical Properties of Materials **+**
- Relate Intermolecular Forces to States of Matter
- Discuss Melting Materials **[2],[3]**
- Make a Claim about Extruded Materials
- Discuss the Masses of one Mole **[2],[3]**
- Reaction Reasoning
- Predict Whether a Precipitate Will Form
- Stoichiometry
- A Measure of Success
- Compare Heats of Formation

Writing about Science/Other Activities

- States of Water **+, [1],[2]**

- Solubility and Temperature **+**
- Counting Tiny Objects **[1],[2],[3]**
- Track the Mass of Reactants and Products **+**
- Parts and the Whole **+,[2],[3]**
- A Scale that Reads Moles **+**
- Energy Input for the Rusting of Iron **+**
- Enthalpy of Reaction vs Phase Change **+**

Suggested Assessments

- 3D Assessment Physical Properties of Materials
- Performance Based Assessment: Road Deicers ★**[2],[3]**
- 3D Assessment Chemical Quantities
- Performance Based Assessment: Analysis of Basic Copper Carbonate ★**[1]**
- 3D Assessment Chemical Reactions
- Performance Based Assessment: Identify Evidence of a Chemical Reaction★**[2],[3]**
- 3D Assessment Stoichiometry
- Performance Based Assessment: The Stoichiometry of Filling a Balloon ★**[2],[3]**
- 3D Assessment Thermochemistry
- Performance Based Assessment: Enthalpy of a Neutralization Reaction ★**,[2],[3]**
- Pencil and paper teacher generated assessments

UNIT 4 - Segment 4: Chemistry of Climate Change

Students develop models of energy flow in Earth's climate. They revisit combustion reactions from IS1 to focus on emissions from fossil fuel energy sources. They apply models of the structures of molecules to explain how different molecules trap heat in the atmosphere. Students evaluate different chemical engineering solutions that can reduce the impacts of climate change.

Standards Addressed

HS-ESS2-2.
HS-ESS2-4.
HS-ESS2-6.
HS-ESS3-2.
HS-ESS3-5.
HS-ESS3-6.

Instructional Objectives

Students will be able to answer the following **essential questions** via the corresponding *competencies*:

What is causing drought in California?

1. *Students identify severe weather and evaporation feedback and use this to explain the cause of drought. They then apply this to why there is an increase in extreme weather events.*
2. *Students explain why the complete disappearance of a glacier is an example of a nonlinear tipping point and relate that to what causes drought in California.*
3. *Students explain why most of the world's deserts are located at the poles and relate that to the phenomenon of what causes drought in California.*
4. *Students analyze evaporation feedback and use this to refine explanations on what causes drought in California.*
5. *Students use their knowledge of climate zones to refine explanations on what causes drought in California.*
6. *Students apply knowledge of how humans have impacted climate to refine explanations on what causes droughts in California.*

What is causing an increase in floods?

1. Students use the greenhouse effect and climate models to explain the cause of an increase in floods. They apply this knowledge to an increase in other extreme weather events.

2. Students construct an explanation of how surface water might contribute to the greenhouse effect and relate that to the phenomenon of what is causing an increase in floods.

3. Students describe how melting ice could affect the frequency and intensity of flooding events.

4. Students describe how greenhouse gas emissions affect the frequency and intensity of flooding events.

5. Students explain what CESM projections predict about the likelihood of flooding in the future.

6. Students use knowledge of coastal flooding, droughts, and floods to refine explanations on what is causing an increase in floods.

7. Students describe engineering solutions to flooding and use this to refine explanations on what is causing an increase in floods.

Suggested Activities

Problem Based Learning/We Research

- Water as a Greenhouse Gas **+**

Authentic Readings/Worksheets

- An Unexpected Side-Effect of Drought **+**
- Geoengineering and Climate Change **+**

Labs

1. Feedback and Climate Change
2. Energy in the Atmosphere
3. Albedo and Composition of Earth's Surface
4. How Melting Ice Affects Sea Level ★
5. Observe Air Pollution
6. Carbon Dioxide and its Role in Climate
7. How Nature Records Changes in the Environment **[1],[2]**
8. Human Activity and Carbon Emissions ★
9. Model Climate Change with Melting Ice
10. Climate Change and Keeping Cool
11. Solar Cell Technology ★

Computer Simulations

- The Carbon Cycle **+**
- Sampling the Past **+**
- Molecules and Light – PhET Simulation
- Flow of Energy and Greenhouse Gases **+**
- Glaciers on Rainier **+**
- Climate Change and Fire **+**
- Energy Forms and Changes – PhET Simulation
- Wetlands and the Carbon Cycle **+**

Analyzing Data

- Influence of Dams on Coastal Erosion **+, [2]**
- Balance the Energy Budget **+**
- Energy In and Out of the Earth's Atmosphere **+, [1]**

- Historical Carbon Dioxide Levels **+,[1],[2]**
- Solar Output **+**
- Earth's Energy Equilibrium **+,[1],[2]**
- Volcanic Emissions and Climate Over Time **+**
- Tree Rings and Climate Change **+**
- Keeling Curve **+**
- Carbon Absorption **+,[2]**
- Climate Change and Drought **+**
- Climate Change and the Biosphere **+,[1],[3]**
- Ecological Footprint **+**

Modeling Activities

- Milankovitch Cycles **[1],[2],[3]**
- Carbon and the Atmosphere
- Interfering with the Carbon Cycle
- Graph Climate Change **[1],[2],[3]**
- Model Your Carbon Footprint

Engineering Design Challenge

- Design a Green Roof **+**

CERs

- Discuss the phenomenon: Drought Descriptors
- Feedback and Melting Glaciers
- Drought Causes **[2],[3]**
- Discuss the Wetland Effect
- Heat Expansion
- Drought Descriptors
- Ice Core: Records of Climate Change
- Sea Levels Rising **[2],[3]**
- Global Climate Change

Writing about Science/Other Activities

- Draft a Proposal to Reduce CO_2 Emissions **+, [3]**
- Snowball Earth **+, [1]**
- Reduce the Car Industry's Footprint **+**

****Additional and updated data and resources related to global climate change can be found with the following resources suggested by the California Framework:**

- Relevant CDE Resources
- Relevant EEI Resources

Suggested Assessments

- 3D Assessment Weather and Climate
- Performance Based Assessment: Microhabitat in a bottle ★
- 3D Assessment Global Climate Change
- Performance Based Assessment: Climate Change and the Carbon Cycle ★,[1],[3]
- Benchmark 3-D Assessment: Instructional Segments 4 and 5
- Pencil and paper teacher generated assessments

UNIT 5 - Segment 5 : Dynamics of Chemical Reactions and Ocean Acidification

Students investigate the effects of fossil fuel combustion on ocean chemistry. They develop models of equilibrium in chemical reactions and design systems that can shift the equilibrium between the air, water and carbonate shells of ocean creatures. Students conduct research on the interaction between ocean water and shell-building organisms.

Standards Addressed

HS-PS1-5.
HS-PS1-6.
HS-PS1-7.
HS-ESS2-2.
HS-ESS2-6.

Instructional Objectives

Students will be able to answer the following **essential questions** via the corresponding *competencies*:

How can you alter chemical equilibrium and reaction rates?

1. *Students use mathematics to calculate and explain reaction rates. They develop models of collision theory*
2. *Students develop a model of activation energy.*
3. *They design a solution for alternatives to the use of enzymes. Students use models to explain multistep mechanisms of reaction rates*
4. *Students relate chemical equilibrium to everyday examples. They explore Le Châtelier's principle. Students describe patterns in how temperature and pressure affect equilibrium.*

How can you predict the relative quantities of products in a chemical reaction?

5. *Students will utilize knowledge of Le Chatelier's principle to explain how increasing acidity of precipitation affects the processes that form limestone caves.*

How do limestone caves form?

6. *Students use reaction rates and energy diagrams to explain how limestone caves form.*
7. *They apply this toward explaining reactions that cause ocean acidification*

How does acid rain impact the environment?

8. *Students use acid-base reactions to explain how acid rain impacts the environment. They apply this knowledge towards explaining ocean acidification.*

What is happening to the world's coral reefs?

9. *Students use knowledge on ocean factors, such as pH and alkalinity, to explain what is happening to coral reefs and how humans contribute to ocean acidification*

Suggested Activities

Problem Based Learning/Web Research

- Reducing carbon footprints **+**

Authentic Readings/Worksheets

- Boring Sponges **+**

Labs

- Reaction rates: Iodine clock ★,[1],[2]or other comparable phenomenon
- Factors affecting rates of reaction #
- Collision theory
- Explore chemical equilibrium
- Equilibrium shifting **+,[1],[3]**
- Measure acid strength
- Titrations-The Study of Acid-Base Chemistry ★
- Analysis of Buffer Solutions and Ranges
- Quantitative Analysis of Acid Rain
- the pH of Seawater ★
- Carbon dioxide Levels in Water
- The Fate of Carbonate in Acidifying Oceans ★
- Ocean currents

Computer simulations

- Explore the relationship between collisions and activation energy **+**
- Reaction rates and activation energy **+,[2],[3]**
- Collisions and activation energy **+**
- Exploring Acid Strength and Concentration **+**
- acid and base solutions
- pH scale **[2],[3]**
- Explore buffer Systems **+,[1],[2]**
- Ocean pH simulation **+**
- El Niño, La Niña, and Heat Storage - (animation) **+**
- The Effect of Ocean acidification on shells **+**

Analyzing Data

- Factors that Affect Reaction Rate **+**
- Interpret Energy Diagrams **+,[1],[2]**
- Stoichiometric Analysis of Vinegar **+**
- Salt Hydrolysis **+**
- Pacific Ocean pH Changes **+**
- Greenhouse Gas Emissions and Climate Change **+**
- The Changing Ocean and the Biosphere **+**
- Correlating Flu outbreaks and La Niña weather patterns **+,[1],[3]**

Modeling Activities

- Model factors that affect reaction rate
- Reaction rate and molecular collisions **+**

- Compare equilibrium positions of weak acids
- Conductivity of strong and weak acids **+**
- Model an Acid-Base Titration [2],[3]
- Modeling Carbon Flow in the Ocean

Engineering Design Challenge
- Use Equilibrium for a commercial application **+**
- Design a natural pH indicator **+**
- Design a model of Ocean acidification **+**

CERs
- Discuss the Phenomenon of "A drop at a Time"
- The concept of activation energy
- Optimize a Reversible Reaction
- Discuss the phenomenon of Fishless lake in Adirondacks +
- Acid Rain Tolerance
- The Changing Ocean and Coral Reefs
- Ocean Acidity [2],[3]
- Hurricanes and the Carbon Cycle
- Changing Climate and Ocean Ecosystems

Writing About Science/Other Activities
- Glow sticks and Reaction rate **+**
- Compare acid-base models **+**
- CO_2 Scrubbing **+**
- Earth's Position in Space Affects the Climate **[2],[3]**
- CO_2, Ocean acidification, and shell formation +

Problem-Based Learning Experience
- Reducing Carbon Footprints **+**

Suggested Assessment
- Performance based assessment relating reaction rates and equilibrium ★,[2],[3]
- Performance based assessment Quantitative analysis of acid rain ★,[1],[2]
- Performance based assessment Calcium carbonate and shell production ★,[1],[3]
- Interactive online quizzes provided by the publisher
- 3-D Assessment: Reaction Rates and Equilibrium
- 3-D Assessment: Acid-Base Equilibria
- 3-D Assessment: Ocean Acidification
- Benchmark 3-D Assessment: Instructional Segments 4 and 5
- Interactive ExamView 3-D assessment
- Pencil and paper teacher generated assessments

Sacramento City Unified School District

COURSE OF STUDY

FOR

ELD Physics in the Universe
QPS260/ QPS261

Segment	High School
Length of Course	One Year
Developed by	Melanie Bean
First Edition	2020

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

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ELD Physics in the Universe

SECTION ONE — GENERAL INFORMATION

COURSE DESCRIPTION

The purpose of ELD Physics in the Universe is for English Learners to learn and apply interdisciplinary academic and literacy skills through the meaningful use of language, using the California English Language Development Standards; Next Generation Science Standards; California Standards for Literacy in History-Social Studies, Science, and Technical Subject 6-12; and California Standards for Career Ready Practice. This course focuses on language and literacy development through the lens of the science and engineering practices and the cross-cutting practices identified in the California NGSS. ELD Physics in the Universe integrates earth science into Physics through the lens of language acquisition. It is aimed at building a solid foundation in physical science, integrating an intensive laboratory component the consists of literacy strategies, classroom labs, and practical field studies, as well as building student competency in academic language, discourse, science practices, and cross cutting concepts. This course devotes at least 40% of the class time to student-centered laboratory actives that emphasize language, inquiry, and critical thinking. Throughout this course, students will progressively grow in their language development and physics knowledge and use this collective knowledge to explore and design and efficient means of producing renewable energy.

RATIONALE

ELD Physics in the Universe will provide access to core content within the English Learner newcomer pathway (English Learner: overall ELPAC score of 1 or 2 and enrolled in U.S. schools for fewer than three years). This course will fulfill the Physical Sciences with lab requirement for A-G and graduation within Sacramento City Unified School District while supporting English Language Development.

COURSE GOALS

Upon completion of this course, students will be able to:

- Demonstrate proficiency in meeting the Next Generation Science Standards recommendations for physical science;
- Demonstrate proficiency in meeting the California English Language Development high school grade-level standards;
- Demonstrate proficiency in meeting the English Language Arts Literacy Standards for Technical Subjects and College and Career Readiness Standards high school grade-level standards.

COURSE STANDARDS

Next Generation Science Standards for High School: Physical Sciences; Earth and Space Sciences; Engineering, Technology, and Applications of Science

INSTRUCTIONAL MATERIALS

Physics in the Universe; Accelerate Learning 2019

SUPPLEMENTARY MATERIALS:

Lab Activities
Translation devices

SUGGESTED AVERAGE TIME FOR COVERING MAJOR UNITS

ELD Physics in the Universe will devote no less than 40% of instructional time to hands-on laboratory investigations that support instruction. Each of the six units will approximately take 30 instructional days.

TEACHER RESOURCES

Physics in the Universe; Accelerate Learning 2019

RECOMMENDED STUDENT RESOURCES

Student Text (Physics in the Universe), Digital Curriculum Access
Translation devices/ apps
Bilingual dictionaries

SECTION TWO — COURSE UNITS

All units are designed using the California English Language Development Standards for Grades 9-12 to deliver Next Generation Science Standards

UNIT I: Forces and Motion of Objects in the Universe

Newton's Laws provide a basis of understanding forces and motion, and therefore, serve as a foundation for a study of physics. Students will need to collaboratively construct a device in order to address an engineering design challenge built on the background of Newton's Laws and momentum. In order to meet this challenge, students will develop models of the challenge, and design and revise their design based on data and their knowledge of physics. Students will begin by investigating collisions, and by dissecting a collision and describing the motion of objects. They will do this by developing models of motion and forces, conducting experiments, gathering data, and revising their models. To support this learning, students will interpret tables and graphs of position and velocity as a function of time for objects subjected to a constant, net unbalanced force and compare their observations to predictions from mathematical models. Students will develop models of motion of falling objects, and gather data to improve their models, and explain the concept of acceleration due to the gravitational force by means of data analysis. Students will use data to prove that technological advancements such as airbags and crumple zones reduce the force of an impact by analyzing videos of collisions and by measuring impact time and impact forces for different collisions. Students will apply their knowledge in order to complete the engineering design challenge. Students will engage with grade-level, intellectually-rich scientific content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards.

Sample Guiding Questions:

- How can Newton's Laws be used to explain how and why things move?
- How can mathematical models of Newton's Laws be used to test and improve engineering designs?
- How can you minimize the force on a macroscopic object during a collision?

NGSS Standards Addressed

HS-PS2. Motion and Stability: Forces and Interactions
HS-ETA1. Engineering Design

Instructional Objectives

Students will be able to:

- Students will analyze the motion of balls on different inclined planes.
- Students will use kinematic equations in order to measure the height of buildings.
- Students will qualitatively and quantitatively analyze a cart stopping with varying impact times based on different structural materials.
- Students will choose a problem and engineer a solution to the problem using their knowledge of Newton's Law and momentum. Possible problems could consist of football helmet collisions, crumple zones for cars, dropping cargo from airplanes, etc.

Suggested Activities

Summary of Sample Assignment: Students will read articles and watch video clips of scenarios involving change in momentum including car collisions, bungee jumps, a man falling onto the top of a car, objects being dropped from a plane, etc. Students will then draw visual models to describe how these collisions affect impact force and impact time.

- Per the California English Language Development Standards and Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Two car manufacturers are claiming their cars are the fastest. In this activity, students will receive a data table that includes each car's make and model, its horsepower, the force of its engine, and the time each car takes to travel a given distance. Students need to prove which manufacturer has the fastest car, using the concepts of Newton's second law.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT II: Forces at a Distance

In this unit the foundation of forces and motion are used to predict and explain gravitational and electromagnetic interactions that occur at a distance. Students investigate gravitational and electromagnetic forces through a series of small experiments and describe them conceptually and mathematically. They predict the motion of orbiting objects in the solar system. They link the macroscopic properties of materials to microscopic electromagnetic attractions (charge, Coulomb's law). Students will use mathematical models to explore Newton's Law of Gravitation to describe and predict the gravitational attraction between two objects, then compare the Law of Gravitation to Coulomb's Law to conclude that gravitational and electrostatic forces share a common geometry, radiating out as spherical shapes from their point of origin. Students will engage with grade-level, intellectually-rich scientific content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards.

Sample Guiding Questions:

- How can different objects interact when they are not touching?
- How do interactions between charges at the microscopic scale affect the macroscopic properties of matter that we observe?
- How do satellites stay in orbit?

NGSS Standards Addressed

HS-PS-3. Energy
HS-PS-4. Waves and their Applications in technologies for Information Transfer

Instructional Objectives

Students will be able to:

- Students will develop a visual model to better understand what is happening within charged materials, and then use this as a basis for better understanding the physics of electric charges. They will also demonstrate and explain the process of charge polarization.
- Students will construct a simple DC motor.

Suggested Activities

Summary of Sample Assignment: Students will construct a model for satellite motion by analyzing data from PHeT Gravity and Orbits simulation. The changes of mass and distance are modeled and applies to the Universal Gravitation equation.

- Per the California English Language Development Standards and Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students will create different ellipses to simulate planetary orbits and discover the mathematical relationships that led Kepler to formulate his first law of planetary motion. Students will use solar system-object data to calculate eccentricities of the objects for comparison and then write a scientific explanation for why average distance is used for planets. Students will use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT III: Energy Conversion & Conservation Laws

Students will differentiate between kinetic, potential, and thermal energy and be able to calculate the change in the energy of a system from one form to another showing that energy is conserved. Students investigate different methods of energy production and energy transfer. During this unit students will track energy transfer and conversion through different stages of commercial and residential power sources. They will also evaluate different power source technologies. This may include investigations with electromagnetism and solar photovoltaic systems to create models of how power generation works. They also may include the design and testing of their own energy conversion devices. Students will engage with grade-level, intellectually-rich scientific content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards.

Sample Guiding Questions:

- How can electricity be generated?
- How can energy be harnessed to perform useful tasks?
- What engineering designs can help increase energy efficiency?
- What happens to energy after it has been used to perform a task?

NGSS Standards Addressed

HS-PS-3. Energy
HS-PS-4. Waves and their Applications in technologies for Information Transfer

Instructional Objectives

Students will be able to:

- Students will build a windmill.
- Student teams research and develop unique models of the various ways electricity is produced. Teams analyze the various models (fossil fuels, nuclear, geothermal, tidal, wind, and solar) to find patterns in the flow of energy and determine the efficiency of each energy source.

Suggested Activities

Summary of Sample Assignment: Students will design and construct a windmill. Students will be given a mock budget and have limited resources that they can purchase. Each group will also be given a small DC motor which will double as the generator. The students will research different windmill designs and will draw blueprints of their final design plan. After the windmills have been constructed the class will measure the amount of current each

windmill produces. The class will have a discussion about what made designs successful and unsuccessful.

Per the California English Language Development Standards and Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students will use an online simulation to observe how changing magnetic fields can produce an electric current. Then, they will draw two diagrams, one that shows how electric currents produce magnetic fields and another that shows how changing magnetic fields produces electric current.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT IV: Nuclear Processes and Earth History

Students develop a model of the internal structure of atoms and then extend it to include the processes of fission, fusion, and radioactive decay. They apply this model to understanding nuclear power and radiometric dating. They use evidence from rock ages to reconstruct the history of the Earth and processes that shape its surface. Students will engage with grade-level, intellectually-rich scientific content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards.

Sample Guiding Questions:

- How do nuclear reactions illustrate conservation of energy and mass?
- Why are some materials dangerous, emitting harmful radiation?
- How do we determine the age of rocks and other geologic features?
- How can we determine the age of the earth?

NGSS Standards Addressed

HS-PS1. Matter and its Interactions
HS-PS2. Motion and Stability: Forces and Interactions

Instructional Objectives

Students will be able to:

- Students will use a model to explain the changes in the makeup of the nucleus of an atom and explain the release of the energy. Groups pick fission, fusion, alpha, beta, gamma – explain model to class.
- Students will develop models of seafloor spreading.

Suggested Activities

Disciplinary Core Ideas:

- **C:** Nuclear Processes
- **C:** The History of Planet Earth
- **A:** Earth Materials and Systems
- **B:** Plate Tectonics and Large-Scale System Interactions

Summary of Sample Assignment: Students will draw a visual model of how convection currents work in the core of the earth. In order for students to draw this model the students will fill a transparent, rectangular tub with water. Two hot cups of water are placed underneath the two ends of the tub and one cold cup of water is placed underneath the middle of the tub. A few drops of red dye are placed inside the tub just above the hot cups and a few drops of blue dye are placed inside the tub just above the cold cup. Students will then observe the convection currents. After drawing their models the students will make claims on how they think convection currents impact the theory of plate tectonics.

Per the California English Language Development Standards and Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students will be working within expert groups to research one topic within the solar nebula theory. Students will present their research to the class and obtain data on topics that they did not research as they listen to other presentations. They will be regrouped and use this collected data to create a complete account of how Earth and the solar system were formed and create a timeline of events.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT V: Waves and Electromagnetic Radiation

Students make mathematical models of waves and apply them to seismic waves traveling through the Earth. They obtain and communicate information about other interactions between waves and matter with a particular focus on electromagnetic waves. They obtain, evaluate, and communicate information about health hazards associated with electromagnetic waves. They use models of wave behavior to explain information transfer using waves and the wave-particle duality. Students look at data sets from various satellites and telescopes to demonstrate how knowledge of electromagnetic radiation helps humans to understand their surroundings, whether it be weather patterns on Earth, the temperature of the Earth, the ages of stars in distant galaxies, or the atmospheric composition of planets in our solar system and beyond. Students will engage with grade-level, intellectually-rich scientific content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards.

Sample Guiding Questions:

- How do we know what is inside the Earth?
- Why do people get sunburned by UV light?
- How can we transmit information over wires and wirelessly?
- How is music created and transmitted?

Standards Addressed

HS-PS-3. Energy
HS-PS-4. Waves and their Applications in technologies for Information Transfer

Instructional Objectives

Students will be able to:

- Students will observe wave properties of transverse and longitudinal in different mediums.
- Students will design a musical instrument and determine how wave properties change the output (frequency, amplitude, wavelength) and tune the instrument to a specified frequency so that an orchestra of peers can play a simple 4 note song.
- Students will research past natural disasters, work with materials to understand stress and faulting, test ocean waves vs tsunami wave properties, learn about seismic waves, how they affect us, test seismic engineering solutions, and learn about and test mitigation efforts for tsunamis.

Suggested Activities

Summary of Sample Assignment: Students will use long slinkys to observe wave pulses, wave interference, transverse waves, longitudinal waves, wave speed, and standing waves. Each group will have to present to the class a minimum of three claims based on their observations using the claim, evidence, reasoning structure.

Per the California English Language Development Standards and Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

In this activity, students will use a Slinky to model the structure and function of seismic waves (S-waves and P-waves) to visualize how they can be used to investigate the layers of Earth.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT VI: Stars and the Origin of the Universe

Students apply their model of nuclear fusion to trace the flow of energy from the Sun's core to Earth. Students will apply their knowledge of the doppler effect to the concept of redshift and blueshift in astronomy in order to defend a claim about the expansion of our universe. They will use evidence from the spectra of stars and galaxies to determine the composition of stars and construct an explanation of the origin of the Universe. Students will engage with grade-level, intellectually-rich scientific content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards.

Sample Guiding Questions:

- How do we know what stars are made of?
- What fuels our Sun? Will it ever run out of fuel?
- Do other stars work the same way as our Sun?
- How do patterns in motion of the stars tell us about the origin of our Universe?

Standards Addressed

HS-ESS-1. Earth Place in the Universe

Instructional Objectives

Students will be able to:

- Students will develop visual models of how energy is transformed and transferred from the core of the earth to the earth's surface.
- Students will research the life cycles of different stars and how the mass of a star and its current stage of life determines what elements are created.

Suggested Activities

Summary of Sample Assignment:

Students will work in small groups discussing, researching and collaborating to develop and design a model that follows the thermodynamic principles to explain and demonstrate how heat flows in a system and the concept of entropy. Their model will be applied to explain nuclear processes and heat transfer in a closed system. Students will then demonstrate how energy is transferred and transformed specifically as it pertains to the earth's internal nuclear processes. Students will further develop this model and explain how fusion processes work in the formation and life of a star. Students will work collectively on computers to create a presentation on a star of their choice. They will research the life cycles of that star and how the mass and its current stage of life determines what elements

are created. They will be required defend their reasoning based on evidence and valid scientific research, citing valid sources if the information is not obtained in class.

Per the California English Language Development Standards and Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students will perform a kinesthetic model to illustrate the changes that occur in a star during its life cycle. This will be done for both a low- to medium-mass star and a high-mass or a massive star. Students will learn that the lifespan of stars is based primarily on initial mass and that the Sun is a low- to medium-mass star with a 10 billion-year life span. Students will also learn about the hydrogen-to-helium product and how that predicts a star's age.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Sacramento City Unified School District

COURSE OF STUDY

FOR

ELD Biology: The Living Earth
QBS273/ QBS274

Segment	High School
Length of Course	One Year
Developed by	Melanie Bean
First Edition	2020-2021

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

BOARD OF EDUCATION APPROVED ON:

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Christina Pritchett, 1st Vice President, Trustee Area 3
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Committee

Multilingual Literacy Office

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ELD Biology: The Living Earth

SECTION ONE — GENERAL INFORMATION

COURSE DESCRIPTION

The purpose of ELD Biology: The Living Earth is for English Learners to learn and apply interdisciplinary academic and literacy skills through the meaningful use of language, using the California English Language Development Standards; Next Generation Science Standards; California Standards for Literacy in History-Social Studies, Science, and Technical Subject 6-12; and California Standards for Career Ready Practice. This course focuses on language and literacy development through the lens of the science and engineering practices and the cross-cutting practices identified in the California NGSS. Students will study the biological concepts of ecosystems, genetics, evolution and cells to organisms. Standards of Earth and space science such as Earth's history and global climate change will also be used to deepen student understanding of the concepts that are being learned. Students will spend a minimum of 20% of classroom time engaged in hands-on laboratory investigations that support science and language instruction.

RATIONALE

ELD Biology: The Living Earth will provide access to core content within the English Learner newcomer pathway (English Learner: overall ELPAC score of 1 or 2 and enrolled in U.S. schools for fewer than three years). This course will fulfill the Life Science with lab requirement for A-G and graduation within Sacramento City Unified School District while supporting English Language Development.

COURSE GOALS

Upon completion of this course, students will be able to:

- Demonstrate proficiency in meeting the Next Generation Science Standards recommendations for life science;
- Demonstrate proficiency in meeting the California English Language Development high school grade-level standards;
- Demonstrate proficiency in meeting the English Language Arts Literacy Standards for Technical Subjects and College and Career Readiness Standards high school grade-level standards.

COURSE STANDARDS

Next Generation Science Standards for High School: Life Sciences; Earth and Space Sciences; Engineering, Technology, and Applications of Science

INSTRUCTIONAL MATERIALS

STEMscopes by Accelerate Learning 2019

SUPPLEMENTARY MATERIALS:

Lab Activities
Translation devices

SUGGESTED AVERAGE TIME FOR COVERING MAJOR UNITS

ELD Biology: The Living Earth will devote no less than 20% of instructional time to hands-on laboratory investigations that support instruction. Each of the six units will approximately take 30 instructional days.

TEACHER RESOURCES

STEMscopes instructional materials and online platform

RECOMMENDED STUDENT RESOURCES

Student Text (STEMScopedia), Digital Curriculum Access
Translation devices/ apps
Bilingual dictionaries

SECTION TWO — COURSE UNITS

All units are designed using the California English Language Development Standards for Grades 9-12 to deliver Next Generation Science Standards

UNIT I: Ecosystem Interactions and Energy

In this unit, students will use mathematical and computer models to determine the factors that affect the size and diversity of populations in ecosystems, including the availability of resources and interactions between organisms. Individual and group behavior will be analyzed in order to determine the benefits to individual members of a population. Students will apply their knowledge of carrying capacity, animal behavior and processes that enable matter to cycle and energy to flow in an ecosystem to determine what a species needs for survival. Students will engage with grade-level, intellectually-rich scientific content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards.

NGSS Standards Addressed

HS. Ecosystems: Interactions, Energy, and Dynamics
HS. Interdependent Relationships in Ecosystems
HS. Matter and Energy in Organisms and Ecosystems

Instructional Objectives

Students will be able to:

- Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
- Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

- Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Suggested Activities

Assignment #1: Students will use a simulation tool to analyze data in order to explain the predator-prey relationship between a lynx and a hare. Students will be able to manipulate various factors such as the year and count of each organism in order to graph the relationship between the two.

Assignment #2: Students will model the effects of a parasitic disturbance on a population to explore how diversity and size can affect the resilience of an ecosystem. Cards representing various organisms will be spread out in a small and large ecosystem. Students will then calculate the abundance of each organism in both ecosystems. A parasite will be introduced to both ecosystems resulting in the death of a predetermined number of individuals from each population. Students will graph the abundance of organisms before and after the disturbance and use the data to explain factors that can affect biodiversity.

Assignment #3: Students will be provided with a animal behavior that they will have to research in order to make a claim with evidence and reasoning to evaluate how that behavior is beneficial for an organism or groups behavior.

Per the California English Language Development Standards and the Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students will be analyzing real world data to explain the predator-and-prey relationship between the hare and the lynx, identify the carrying capacity, and explain how changes in factors would affect the population graph and carrying capacity.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT II: History of Earth's Atmosphere

Students will make links between photosynthesis and respiration in organisms and cycles of energy and matter in Earth systems. Students will create models to understand the molecules that form the basis of the living earth. They will discover how this knowledge can be applied to our world to connect the past, the present, and the future. Students will engage with grade-level, intellectually-rich scientific content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards.

NGSS Standards Addressed

HS. Ecosystems: Interactions, Energy, and Dynamics
HS. Interdependent Relationships in Ecosystems
HS. Matter and Energy in Organisms and Ecosystems
HS. From Molecules to Organisms: Structures and Processes

Instructional Objectives

Students will be able to:

Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

- Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
- Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Suggested Activities

Assignment #1: Students will model the chemical equations of photosynthesis and cellular respiration to see how energy and matter are transferred and flow from process to process. They will also explore which process stores and releases energy for use in organisms.

Assignment #2: Students will model how lipids, proteins, and nucleic acids are formed from glucose and other substances from the surrounding environment. They will then write a

scientific explanation that includes a claim, evidence, and reasoning (CER) to answer the question, “If you lived only on a diet of sugars, could you survive?

Assignment #3: Students research the origin of atmospheric oxygen and prepare a group poster that highlights the dynamic changes in our atmosphere from the formation of Earth through today. Afterward, students display posters for a gallery walk and share responses.

Per the California English Language Development Standards and the Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students will model the chemical equations of photosynthesis and cellular respiration to see how energy and matter are transferred and flow from process to process. They will also explore which process stores and releases energy for use in organisms.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connection

UNIT III: Evidence of Evolution

Students will analyze the different types of evidence, such as rock layers, fossils, anatomical structures, DNA sequences and embryology, that scientists use to determine the common ancestry of different species. They will construct an explanation on the cause and effect relationship between natural selection and adaptation. Students will also compare and contrast the genetic and environmental conditions throughout Earth's history that leads to the creation or extinction of species. Students will learn about the environmental factors that can affect biodiversity. Students will engage with grade-level, intellectually-rich scientific content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards.

NGSS Standards Addressed

HS. Earth and Human Activity
HS. Biological Evolution: Unity and Diversity
HS. Natural Selection and Evolution

Instructional Objectives

Students will be able to:

- Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
- Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

- Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Suggested Activities

Assignment #1: Students will visit various stations to analyze evidence of common ancestry such as including biogeography, anatomical, developmental, and molecular homologies. Students will look at the evidence of fossils on different continents, compare and contrast analogous and homologous structures, compare the DNA sequences of various organisms and look at different 3 stages of embryological development in order to compare the development of different animals.

Assignment #2: Students will research the different types of evidence used to explain an organism's evolutionary history and relatedness. The information will then be presented to the class.

Assignment #3: Students will learn about factors that influence evolution and then apply those factors to different scenarios in which evolution is occurring. Students will write a scientific claim about which factor they believe has the most influence on the evolution of a species.

Per the California English Language Development Standards and Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students will be given a scenario and data for a city that has suffered some loss of natural resources, change in climate, or natural hazards and will explain what happened to the city in terms of population size, distribution, and migration patterns. Students will address technology's role in each scenario and how it has mitigated effects on human activity, caused human dependence to acquire natural resources and modify physical settings, and changed the cause and effect in the relationship. Students will use evidence to distinguish between causal and correlation relationships between environmental factors and human activity.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT IV: Inheritance of Traits

Students develop explanations about the specific mechanisms that enable parents to pass traits on to their offspring. They make claims about which processes give rise to variation in deoxyribonucleic acid (DNA) codes and calculate the probability that offspring will inherit traits from their parents. Students will study the specific mechanisms that enable parents to pass traits on to their offspring and will discover how this knowledge can be applied to our world. Students will engage with grade-level, intellectually-rich scientific content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards.

NGSS Standards Addressed

HS. Heredity: Inheritance and Variation of Traits
HS. Biological Evolution: Unity and Diversity
HS. Natural Selection and Evolution

Instructional Objectives

Students will be able to:

- Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

- Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
- Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
- Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
- Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Suggested Activities

Assignment #1: Using an example of DNA, students will explore how gene expression dictates cell function and how expression can be influenced by environmental factors. Students will explain how genes are affected by environmental factors in different types of animals.

Assignment #2: Students will examine the process of natural selection by analyzing the peppered moth populations before and after the Industrial Revolution in England. Students will also examine the scientific process by analyzing this study and its flaws as well as the follow-up studies of the peppered moth population.

Assignment #3: Students will research and takes notes on the factors that cause skin cancer. Using their research, students will engage in a debate on whether skin cancer is more frequently caused by genetic or environmental factors.

Per the California English Language Development Standards and the Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Using an example of DNA, students will explore how gene expression dictates cell function and how expression can be influenced by environmental factors. Students will look at a diagram that shows a segment of DNA found in four different types of cells: heart, skin, liver, and eye. The genes are shaded in different colors and have the words “ON” and “OFF” underneath them. Students will use the diagram to analyze data and make predictions.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT V: Structure, Function and Growth (from cells to organisms)

Students use models to create explanations of how cells use DNA to construct proteins, build biomass, reproduce, and create complex multicellular organisms. Students will be able differentiate between DNA, genes and chromosome and how each functions in an organism. Students will investigate cellular division, and how organisms maintain homeostasis through feedback systems. Students will engage with grade-level, intellectually-rich scientific content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards.

NGSS Standards Addressed

HS. From Molecules to Organisms: Structures and Processes
HS. Ecosystems: Interactions, Energy, and Dynamics

Instructional Objectives

Students will be able to:

- Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
- Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Suggested Activities

Assignment #1: Students will construct a line graph of the amount of DNA during the cell cycle. Next, using the graph they constructed, they will draw a comic strip illustrating what happens to a cell during the cell cycle. Then, they will write a scientific explanation that includes a claim, evidence, and reasoning (CER) to answer the question, "Which frame of your comic strip represents the cell dividing?

Assignment #2: Students will build a model of DNA using puzzle pieces.

Assignment #3: Students will use various indicators to test for the presence of macromolecules such as proteins, lipids and carbohydrates in different foods. When given an unknown food sample, students will have to test and identify the macromolecules that can be found in the unknown sample.

Per the California English Language Development Standards and the Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students will construct a line graph of the amount of DNA during the cell cycle. Next, using the graph they constructed, they will draw a comic strip illustrating what happens to a cell during the cell cycle. Then, they will write a scientific explanation that includes a claim, evidence, and reasoning (CER) to answer the question, "Which frame of your comic strip represents the cell dividing?

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT VI: Ecosystem Stability & the Response to Climate Change

Students use computer models to investigate how Earth's systems respond to changes, including climate change. Students will analyze the effects that human activities have on the environment and biodiversity. They make specific forecasts and design solutions to mitigate the impacts of these changes on the biosphere. Students will engage with grade-level, intellectually-rich scientific content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards.

NGSS Standards Addressed

HS. Matter and Interactions
HS. Energy
HS. Ecosystems: Interactions, Energy, and Dynamics
HS. Biological Evolution: Unity and Diversity
HS. Earth and Human Activity
HS. Weather and Climate
HS. Human Sustainability
HS. Engineering Design

Instructional Objectives

Students will be able to:

- Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
- Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
- Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
- Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*
- forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
- Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Suggested Activities

Assignment #1: Working in pairs, students will use computer simulations to create a computational model of the effect of human-generated carbon dioxide on the relationships between Earth systems. Using mathematical representations, students will communicate the effects of melting permafrost, new vegetative growth, wildfires, and human emissions have on the Earth. The models and mathematical representations will be used to predict changes in Earth's global climate.

Assignment #2: Students will research an assigned ecosystem to determine which factors affect biodiversity the greatest. They will gather and synthesize their research onto a poster board to then present in a gallery walk and take a stance about which factor has the greatest impact on a global scale.

Assignment #3: Students will be presented with various types of data about the bee-colony population. They will analyze and interpret the data to make a claim about the causes of the population decline. Students will support their claim with the evidence that they have been provided. Students will share their claim and listen to the claim of other groups in order to make revisions.

Per the the California English Language Development Standards and the Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

As part of the Engineering Design Process (EDP), students are presented with a challenge to “attend the Ocean Conference as a presenter on the human impacts on the acidification of the ocean, with a focus on the cause and possible solutions to these impacts.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Sacramento City Unified School District

COURSE OF STUDY

FOR

ELD Chemistry in the Earth System
QCS302/ QCS303

Segment	High School
Length of Course	One Year
Developed by	Melanie Bean
First Edition	2020

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

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ELD Chemistry in the Earth System

SECTION ONE — GENERAL INFORMATION

COURSE DESCRIPTION

The purpose of ELD Chemistry in the Earth System is for English Learners to learn and apply interdisciplinary academic and literacy skills through the meaningful use of language, using the California English Language Development Standards; Next Generation Science Standards; California Standards for Literacy in History-Social Studies, Science, and Technical Subject 6-12; and California Standards for Career Ready Practice. This course focuses on language and literacy development through the lens of the science and engineering practices and the cross-cutting practices identified in the California NGSS. In this inquiry-based course, students explore chemical and earth science concepts that build language and comprehension using vigorous investigations. Using the direction of the California Science Framework's High School 3-Course Model, ELD Chemistry in the Earth System will integrate chemistry, Earth science, space science, and the California ELD Standards to deepen students' understanding of how chemical processes help drive the Earth.

RATIONALE

ELD Chemistry in the Earth System will provide access to core content within the English Learner newcomer pathway (English Learner: overall ELPAC score of 1 or 2 and enrolled in U.S. schools for fewer than three years). This course will fulfill the Life Science with lab requirement for A-G and graduation within Sacramento City Unified School District while supporting English Language Development.

COURSE GOALS

Upon completion of this course, students will be able to:

- Demonstrate proficiency in meeting the Next Generation Science Standards recommendations for physical science;
- Demonstrate proficiency in meeting the California English Language Development high school grade-level standards;
- Demonstrate proficiency in meeting the English Language Arts Literacy Standards for Technical Subjects and College and Career Readiness Standards high school grade-level standards.

COURSE STANDARDS

Next Generation Science Standards for High School: Physical Sciences; Earth and Space Sciences; Engineering, Technology, and Applications of Science

INSTRUCTIONAL MATERIALS

Experience Chemistry; Pearson 2019

SUPPLEMENTARY MATERIALS:

Lab Activities

SUGGESTED AVERAGE TIME FOR COVERING MAJOR UNITS

ELD Chemistry in the Earth System will devote time to hands-on laboratory investigations that support instruction. Each of the six units will approximately take 30 instructional days.

TEACHER RESOURCES

Experience Chemistry; Pearson 2019

RECOMMENDED STUDENT RESOURCES

Pearson Experience Chemistry online platform
Bilingual Dictionaries
Translation devices/ apps

SECTION TWO — COURSE UNITS

All units are designed using the California English Language Development Standards for Grades 9-12 to deliver Next Generation Science Standards

UNIT I: Combustion

In this brief introductory unit, students investigate the amount of stored chemical potential energy in food. They make observations of material properties at the bulk scale that they will later explain at the atomic scale. The themes of combustion and CO2 tie together several of the instructional segments.

Essential Question(s):

- What is energy, how is it measured, and how does it flow within a system?
- What mechanisms allow us to utilize the energy of our foods and fuels?

NGSS Standards Addressed

- HS-PS1. Matter and its Interactions
- HS-PS3. Energy

Instructional Objectives

Students will be able to:

Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

Science and Engineering Practices:

- Planning and carry out investigations
- Develop and using models
- Using mathematics and computational thinking

Suggested Activities

Key Assignments may include:

Students work through math problems involving specific heat capacity, solving for heat or temperature change.

Per the California English Language Development Standards and the Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students carry out an investigation using food calorimetry to prove that matter cannot be created or destroyed via chemical reactions, only converted from one form to another despite visual evidence that they might interpret as contrary to the Law of Conservation of Mass.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT II: Heat and Energy in the Earth System

Heat and Energy in the Earth System Students develop models of energy conservation within systems and the mechanisms of heat flow. They relate macroscopic heat transport to atomic scale interactions of particles, which they will apply in later units to construct models of interactions between atoms. They use evidence from Earth's surface to infer the heat transport processes at work in the planet's interior.

Essential Question(s):

- How is energy transferred and conserved?
- How can energy be harnessed to perform useful tasks?

NGSS Standards Addressed

- HS-PS3. Energy
- HS-ESS2-3. Earth's Place in the Universe
- HS-ETS1-4. Engineering Design

Instructional Objectives

Students will be able to:

Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

Develop and use 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 position of particles (objects).

Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Science and Engineering Practices:

- Planning and carry out investigations
- Develop and using models
- Using mathematics and computational thinking

Suggested Activities

Key Assignments may include:

Each student receives a handout of data showing depth and temperature of the Earth's interior. They construct three-line graphs of the data on one graph, plotting temperature versus depth. Students learn the temperatures of the surface of the Earth vary greatly compared to the mantle and the core due to different densities, varying distances from the core and differing rock composition.

Per the California English Language Development Standards and the Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students carry out an investigation to model the process of convection. Students connect their learning to their understanding and model of the Earth's Interior.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT III: Atoms, Elements, and Molecules

Students recognize patterns in the properties and behavior of elements, as illustrated on the periodic table. They use these patterns to develop a model of the interior structure of atoms and to predict how different atoms will interact based on their electron configurations. They use chemical equations to represent these interactions and begin to make simple stoichiometric calculations.

Essential Question(s):

- What is inside atoms and how does this affect how they interact?

NGSS Standards Addressed

- HS-PS1-1. Matter and Interactions

Instructional Objectives

Students will be able to:

Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Science and Engineering Practices:

- Constructing Explanations and designing solutions
- Developing and using models
- Using mathematics and computational thinking

Suggested Activities

Key Assignments may include:

Students may design models to show their understanding of atomic structure. They use this information to predict how atoms of different elements will interact based on their electron configurations. They will do a number of activities to show the patterns and trends on the periodic table with regard to atomic and ionic radius, ionization energy, and electronegativity.

Students will learn how to write names and formulas for both ionic compounds and binary molecular compounds. Ionic compounds may include polyatomic ions. Students will learn how to predict whether compounds are ionic or molecular, based on the position of the elements from Group A on the periodic table.

Per the California English Language Development Standards and the Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students carry out an investigation to identify the compounds with the strongest interparticle forces in a group of compounds, based on observations of physical properties.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT IV: Chemical Reactions

Chemical Reactions Students refine their models of chemical bonds and chemical reactions. They compare the strength of different types of bonds and attractions and develop models of how energy is stored and released in chemical reactions.

Essential Question(s):

- What holds atoms together in molecules?
- How do chemical reactions absorb and release energy?

NGSS Standards Addressed

- HS-PS1-7. Matter and Interactions
- HS-PS2-4. Motion and Stability: Forces and Interactions
- HS-PS3-5. Energy

Instructional Objectives

Students will be able to:

Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

Science and Engineering Practices:

- Planning and carry out investigations
- Developing and using models
- Science and engineering practice

Suggested Activities

Key Assignments may include:

Students will carry out mathematical procedures involving the mole concept, percent composition, empirical and molecular formulas. Students will balance chemical equations and learn the types of chemical reactions. They will carry out stoichiometric calculations relating to mass of product, theoretical yield, and limiting reactant. Students may do a research project about a specific career they are interested in, and how that involves chemistry and chemical reactions.

Per the California English Language Development Standards and the Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students use stoichiometry calculations to predict the mass of product in a reaction, then run the reaction to see how accurate they were.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT V: Chemistry of Climate Change

Students develop models of energy flow in Earth's climate. They revisit combustion reactions from IS1 to focus on emissions from fossil fuel energy sources. They apply models of the structures of molecules to explain how different molecules trap heat in the atmosphere. Students evaluate different chemical engineering solutions that can reduce the impacts of climate change.

Essential Question(s):

- What regulates weather and climate?
- What effects are humans having on the climate?

NGSS Standards Addressed

- HS-ESS2. Earth's Systems
- HS-ESS3. Earth and Human Activity

Instructional Objectives

Students will be able to:

Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Science and Engineering Practices:

- Developing and Using Models
- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking
- Engaging in Argument from Evidence

Suggested Activities

Key Investigations may include:

Students will carry out volume calculations involving a balloon; they may also carry out a computer simulation demonstrating the gas laws. In a lab experiment, students place thermometers in two separate beakers, each heated by a 150-watt light bulb. One jar contains a candle which is lit and then extinguished. This represents a CO2-enhanced atmosphere. The students allow the beakers to reach thermal equilibrium, then turn off the lights, and measure temperature over a 15-minute period. The data is plotted as time versus temperature for both beakers, and draw conclusions about the effect of CO2 on global warming.

Per the California English Language Development Standards and the Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students explore and observe the connection between the increase in greenhouse gases in the atmosphere and the reduction in both sea ice and glacial ice. Using a direct heat source, students compare the amount of ice that is melted as temperature increases in two bottles with different amounts of carbon dioxide in them. Antacid effervescent tablets are added to release additional carbon dioxide in the bottles.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

UNIT VI: Dynamics of Chemical Reactions and Ocean Acidification

Students investigate the effects of fossil fuel combustion on ocean chemistry. They develop models of equilibrium in chemical reactions and design systems that can shift the equilibrium. Students conduct research on the interaction between ocean water and shell-building organisms.

Essential Question(s):

- How can you alter chemical equilibrium and reaction rates?
- How can you predict the relative quantities of products in a chemical reaction?

NGSS Standards Addressed

- HS-PS1-7. Matter and Interactions
- HS-ESS2-6. Earth's Systems

Instructional Objectives

Students will be able to:

Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Science and Engineering Practices:

- Constructing Explanations and designing solutions
- Using mathematics and computational thinking
- Develop and using models

Suggested Activities

Students will study the properties and structure of water, including hydrogen bonding and how that affects its vapor pressure and other characteristics. They will also study solutions and solubility, including common units of concentration such as molarity and percent. Finally, students will study phase changes such as melting and vaporization, noting that such phase changes can be endothermic or exothermic. Students will study reaction rates and the factors that influence them, such as temperature, reactant concentration, surface area, and presence of a catalyst. Collision theory and activation energy are key concepts. Students may compare catalyzed and uncatalyzed energy profiles with regard to reaction rate. Students will study chemical equilibrium, including Le Châtelier's principle. They use Le Châtelier's principle to predict how changes in pressure, temperature, and concentration affect a system at equilibrium. Students will study acids and bases, as well as neutralization reactions. Students will study ocean acidification.

Per the California English Language Development Standards and the Next Generation Science Standards, assignments will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Suggested Assessment

Students will explore the chemistry of calcium carbonate formation in saline solutions resembling seawater. They will investigate how the acidity of the solution and the presence of carbonate or bicarbonate ions affects the formation of calcium carbonate. Finally, students will establish relationships between experimental models, the process of ocean acidification, and the formation of calcium carbonate structures by marine organisms.

Per the California English Language Development Standards and the Next Generation Science Standards, lab activities will support science and language for English language learners through the use of (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections.

Sacramento City Unified School District

COURSE OF STUDY

FOR

ELD American Government
SGS230

Segment:	High School
Length of Course	One Semester
Developed by	Melanie Bean
First Edition	2020

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

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ELD American Government

SECTION ONE — GENERAL INFORMATION

COURSE DESCRIPTION

The purpose of ELD American Government is for English Learners to learn and apply interdisciplinary academic and literacy skills through the meaningful use of language, using the California English Language Development Standards, History/ Social Science Framework, Literacy Standards for History-Social Studies, and California Standards for Career Ready Practice. This course focuses on language and literacy development using content to explore the fundamental principles of American democracy, the rights and responsibilities of an American citizen, and how the United States government works.

RATIONALE

ELD American Government will provide access to core content within the English Learner newcomer pathway. This course will fulfill the Government requirement for A-G and graduation within Sacramento City Unified School District while supporting English Language Development.

COURSE GOALS

Upon completion of this course, students will be able to:

- Demonstrate proficiency in meeting the California History/ Social Science standards and framework recommendations for 12th grade Economics;
- Demonstrate proficiency in meeting the California English Language Development 12th grade standards.

COURSE STANDARDS

California History/ Social Science standards and framework recommendations for 12th grade Economics

California English Language Development Standards for Grades 11-12

California English Language Arts Literacy Standards for History- Social Studies for Grades 11-12

California Standards for Career Ready Practice

INSTRUCTIONAL MATERIALS

Prentice Hall Magruder's American Government Pearson-Prentice Hall, c. 2005

SUPPLEMENTARY MATERIALS:

Tocqueville, Alexis de, 1805-1859. Democracy In America. New York: G. Dearborn & Co., 1838.

"Tribal Nations & the United States: An Introduction." *NCAI*, www.ncai.org/about-tribes.

Primary Source Documents:

Constitution

Declaration of Independence

Federalist Papers

Supreme Court cases

Universal Declaration of Human Rights

SUGGESTED AVERAGE TIME FOR COVERING MAJOR UNITS: ONE SEMESTER

First Quarter

Unit I Fundamental Principles of American Democracy: 2 weeks
Unit II Rights and Responsibilities of Citizens in a Democracy: 2 weeks
Unit III Fundamental Principles of Civil Society: 2 weeks
Unit IV The Three Branches of Government as Established by the U.S. Constitution: 3 weeks

Second Quarter

Unit V The Electoral Process: 2 weeks
Unit VI Federalism: Different Levels of Government: 2 weeks
Unit VII The Role of the Media in American Public Life: 2 weeks
Unit VIII Challenges of Democracy: 3 weeks

TEACHER RESOURCES

Teachers Edition and laptop

RECOMMENDED STUDENT RESOURCES

Student textbooks
Translation devices, laptop, internet access, and bilingual dictionaries

SECTION TWO — COURSE UNITS

All units are designed using the California English Language Development Standards for Grades 11-12 to deliver History/ Social Science Standards

UNIT I: Fundamental Principles of American Democracy

ELD American Government begins with an examination of the ideas that shaped the American democratic system. Students start their studies by reviewing early experiments in democracy, such as the contributions of Greek philosophers, the limited democracy in ancient Athens, and the representative democracy in the Roman republic (and why it eventually failed). They explore the influence of Enlightenment ideas upon the Constitutional framers' support of republicanism, focusing on the key ideas such as John Locke's social contract and his concept of liberty and Charles-Louis Montesquieu's separation of powers. Students engage with grade-level, intellectually-rich historical content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Government) Content Standards Addressed

12.1 Students explain the fundamental principles and moral values of American democracy as expressed in the U.S. Constitution and other essential documents of American democracy.

1. Analyze the influence of ancient Greek, Roman, English, and leading European political thinkers such as John Locke, Charles-Louis Montesquieu, Niccolò Machiavelli, and William Blackstone on the development of American government.
2. Discuss the character of American democracy and its promise and perils as articulated by Alexis de Tocqueville.
3. Explain how the U.S. Constitution reflects a balance between the classical republican concern with promotion of the public good and the classical liberal concern with protecting individual rights; and discuss how the basic premises of liberal constitutionalism and democracy are joined in the Declaration of Independence as "self-evident truths."
4. Explain how the Founding Fathers' realistic view of human nature led directly to the establishment of a constitutional system that limited the power of the governors and the governed as articulated in the Federalist Papers.
5. Describe the systems of separated and shared powers, the role of organized interests (Federalist Paper Number 10), checks and balances (Federalist Paper Number 51), the importance of an independent judiciary (Federalist Paper Number 78), enumerated powers, rule of law,

federalism, and civilian control of the military. 6. Understand that the Bill of Rights limits the powers of the federal government and state governments.

Instructional Objectives

Students will be able to:

Identify and cite primary and secondary source documents;

Close read, annotate, and respond through speaking and writing using a claim, evidence, and reasoning;

Engage in expository/ informational text structures (compare/ contrast; cause/ effect; sequence);

Participate in structured group discussions, simulations, and debates;

Learn and use content, academic, and social interaction vocabulary;

Develop claim, evidence, reasoning, and counterarguments.

Suggested Activities

Students focus on responding to the following essential questions for this unit: Why do we need a government? How much power should government have over its citizens? What do the terms liberty and equality mean, and how do they relate to each other? What are the dangers of a democratic system?

A. Students close read, annotate, and analyze primary source documents, such as: Declaration of Independence, the Federalist Papers and the anti-Federalist response, the Constitution, the Bill of Rights, and the observations of Alexis de Tocqueville.

B. Students participate in mock ratification debates; construct writings or classroom presentations articulating arguments, claims, and evidence from multiple sources; or make classroom presentations demonstrating their understanding and interpretation of primary source documents in response to the essential questions.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, debates, and argument writing.

UNIT II: Rights and Responsibilities of Citizens in a Democracy

Students examine the individual liberties outlined in the Bill of Rights: the origins of individual freedoms, as well as how certain liberties have been restricted in the American democratic system. In addition to political liberties, students explore individual and societal economic, social, and cultural freedoms (including property rights, labor rights, children's rights), as well as the rights necessary to the basic well-boing of all people within a democracy, such as rights to sustenance, education, and health. They consider the path to citizenship and its obligations, such as serving on a jury, paying taxes, obeying the law, voting, and serving in the military. Students engage with grade-level, intellectually-rich historical content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Government) Content Standards Addressed

12.2 Students evaluate and take and defend positions on the scope and limits of rights and obligations as democratic citizens, the relationships among them, and how they are secured.

1. Discuss the meaning and importance of each of the rights guaranteed under the Bill of Rights and how each is secured (e.g., freedom of religion, speech, press, assembly, petition, privacy).
2. Explain how economic rights are secured and their importance to the individual and to society (e.g., the right to acquire, use, transfer, and dispose of property; right to choose one's work; right to join or not join labor unions; copyright and patent).
3. Discuss the individual's legal obligations to obey the law, serve as a juror, and pay taxes.
4. Understand the obligations of civic-mindedness, including voting, being informed on civic issues, volunteering and performing public service, and serving in the military or alternative service.
5. Describe the reciprocity between rights and obligations; that is, why enjoyment of one's rights entails respect for the rights of others.
6. Explain how one becomes a citizen of the United States, including the process of naturalization (e.g., literacy, language, and other requirements).

Instructional Objectives

Students will be able to:

Identify and cite primary and secondary source documents;

Close read, annotate, and respond through speaking and writing using a claim, evidence, and reasoning;

Participate in structured group discussions;

Learn and use content, academic, and social interaction vocabulary;

Develop a proposal, based upon research and data analysis, that serves their community;

Reflect upon effectiveness of a project and personal growth as a learner.

Suggested Activities

Students focus on responding to the following essential questions for this unit: What rights and responsibilities does a citizen have in a democracy? What does it mean to be a citizen? How can citizens improve a democracy?

A. Students close read, annotate, and analyze the primary source documents: the Bill of Rights and the Constitution.

B. Students participate in a civic-based learning activity by creating research questions, doing research and community interviews, developing and writing a proposal with cited evidence, engaging in a project, gathering and analyzing data of effectiveness, and reflecting.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, and a service learning research project.

UNIT III: Fundamental Principles of Civil Society

Students explore the core principles and values of a civil society by asking: what is a civil society, and why do we want to have one? They understand and analyze the tension between majority rules and individual freedom. Students consider the limits of individual freedom and dangers of majority rules. Students review the historical relationship between religion and government, seeking connections between the free exercise of religion outlined in the First Amendment and how that has fostered diversity. They explore the responsibility of the government to protect its citizens and promote social order. Students engage with grade-level, intellectually-rich historical content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Government) Content Standards Addressed

12.3 Students evaluate and take and defend positions on what the fundamental values and principles of civil society are (i.e., the autonomous sphere of voluntary personal, social, and economic relations that are not part of government), their interdependence, and the meaning and importance of those values and principles for a free society.

1. Explain how civil society provides opportunities for individuals to associate for social, cultural, religious, economic, and political purposes.
2. Explain how civil society makes it possible for people, individually or in association with others, to bring their influence to bear on government in ways other than voting and elections.
3. Discuss the historical role of religion and religious diversity.
4. Compare the relationship of government and civil society in constitutional democracies to the relationship of government and civil society in authoritarian and totalitarian regimes.

12.10 Students formulate questions about and defend their analyses of tensions within our constitutional democracy and the importance of maintaining a balance between the following concepts: majority rule and individual rights; liberty and equality; state and national authority in a federal system; civil disobedience and the rule of law; freedom of the press and the right to a fair trial; the relationship of religion and government.

Instructional Objectives

Students will be able to:

Identify and cite primary and secondary source documents;

Close read, annotate, and respond through speaking and writing using a claim, evidence, and reasoning;

Engage in the writing process, edit, and revise;

Participate in structured group discussions, simulations, and debates;

Learn and use content, academic, and social interaction vocabulary;

Develop claim, evidence, reasoning, and counterarguments.

Suggested Activities

Students focus on responding to the following essential questions for this unit: What is a civil society, and why do we want to have one? What are the limits of individual liberty? What are the dangers of majority rule? What is the role of religion in a democracy? How do government actions impact civil society?

A. Students close read, annotate, and analyze the primary source documents: the Bill of Rights and the Constitution.

B. Students identify, research, and write an argument essay on current events that exemplify majority rule, individual liberty, and/or the separation of government and religion.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, and an argument essay.

UNIT IV: The Three Branches of Government as Established by the U.S. Constitution

Students learn about how the U.S. Constitution delineates the unique roles and responsibilities of the three branches of the federal government and the relationship between the federal government and the states. Students focus on Articles I, II, and III of the Constitution to both clarify the individual responsibilities of each branch and detail the connections between branches and the system of separation of powers and checks and balances. Students highlight the Constitution's dual purpose: enumerate power and limit the abuse of power. Students engage with grade-level, intellectually-rich historical content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Government) Content Standards Addressed

12.4 Students analyze the unique roles and responsibilities of the three branches of government as established by the U.S. Constitution.

1. Discuss Article I of the Constitution as it relates to the legislative branch, including eligibility for office and lengths of terms of representatives and senators; election to office; the roles of the House and Senate in impeachment proceedings; the role of the vice president; the enumerated legislative powers; and the process by which a bill becomes a law.
2. Explain the process through which the Constitution can be amended.
3. Identify their current representatives in the legislative branch of the national government.
4. Discuss Article II of the Constitution as it relates to the executive branch, including eligibility for office and length of term, election to and removal from office, the oath of office, and the enumerated executive powers.
5. Discuss Article III of the Constitution as it relates to judicial power, including the length of terms of judges and the jurisdiction of the Supreme Court.
6. Explain the processes of selection and confirmation of Supreme Court justices.

Instructional Objectives

Students will be able to:

Identify and cite primary and secondary source documents;

Close read, annotate, and respond through speaking and writing using a claim, evidence, and reasoning;

Engage in the writing process, edit, and revise;

Participate in structured group discussions, simulations, and debates;

Learn and use content, academic, and social interaction vocabulary.

Suggested Activities

Students focus on responding to the following essential questions for this unit: Why does the Constitution both grant power and take it away? What is the most powerful branch of government? Why does it take so long for government to act?

A. Students study the legislative, executive, and judicial branches by considering the question: Why does the Constitution both grant power and take it away? As students investigate the individual powers of each branch (and the checks upon those powers), they develop their own answer to the question: What is the most powerful branch of government?

B. Students create a presentation by using both historical and current evidence to support their interpretation. Students also work with in groups to debate the topic.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, debates, and argument writing.

UNIT V: The Electoral Process

Students study the role of political parties, the nomination process for presidential candidates, including the primary system, and the role of polls, campaign advertising and financing, the Electoral College, and methods of direct democracy utilized in California and various states. Students also learn about how citizens participate in the political process through voting, campaigning, lobbying, filing legal challenges, demonstrating, petitioning, picketing, and running for office. Students engage with grade-level, intellectually-rich historical content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Government) Content Standards Addressed

12.6 Students evaluate issues regarding campaigns for national, state, and local elective offices.

1. Analyze the origin, development, and role of political parties, noting those occasional periods in which there was only one major party or were more than two major parties.
2. Discuss the history of the nomination process for presidential candidates and the increasing importance of primaries in general elections.
3. Evaluate the roles of polls, campaign advertising, and the controversies over campaign funding.
4. Describe the means that citizens use to participate in the political process (e.g., voting, campaigning, lobbying, filing a legal challenge, demonstrating, petitioning, picketing, running for political office).
5. Discuss the features of direct democracy in numerous states (e.g., the process of referendums, recall elections).
6. Analyze trends in voter turnout; the causes and effects of reapportionment and redistricting, with special attention to spatial districting and the rights of minorities; and the function of the Electoral College.

Instructional Objectives

Students will be able to:

Identify and cite primary and secondary source documents;

Analyze case studies;

Close read, annotate, and respond through speaking and writing using a claim, evidence, and reasoning;

Engage in the writing process, edit, and revise;

Participate in structured group discussions, simulations, and presentations;

Learn and use content, academic, and social interaction vocabulary.

Suggested Activities

Students focus on responding to the following essential questions for this unit: How do you get elected? Who gets elected, and who does not? What impact do polls, political parties, and PACs have upon elections? How can I get involved in a campaign? Why should I vote?

A. Students utilize real-world examples, case studies, and debates. Students study current elections and campaigns and analyze proposed initiatives, controversial issues surrounding campaign financing, voter identification laws, redistricting, and negative campaign ads.

B. Students create a public-service announcement or commercial: possible topics include the importance of voting, how to register to vote (in-person and absentee), and how to be an informed voter; the pros and cons of ballot measures; reasons to support a candidate.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, debates, and an informational public service announcement.

UNIT VI: Federalism: Different Levels of Government

Students analyze the principles of federalism and identify key provisions of the U.S. Constitution that established the federal system. Students discover how power and responsibilities are divided among national, state, local, and tribal governments by constitutional provisions and federal law. They compare how regulatory departments, agencies, and courts function at the local, state, and federal level. Students engage with grade-level, intellectually-rich historical content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Government) Content Standards Addressed

12.7 Students analyze and compare the powers and procedures of the national, state, tribal, and local governments.

1. Explain how conflicts between levels of government and branches of government are resolved.
2. Identify the major responsibilities and sources of revenue for state and local governments.
3. Discuss reserved powers and concurrent powers of state governments.
4. Discuss the Ninth and Tenth Amendments and interpretations of the extent of the federal government's power.
5. Explain how public policy is formed, including the setting of the public agenda and implementation of it through regulations and executive orders.
6. Compare the processes of lawmaking at each of the three levels of government, including the role of lobbying and the media.
7. Identify the organization and jurisdiction of federal, state, and local (e.g., California) courts and the interrelationships among them.
8. Understand the scope of presidential power and decision making through examination of case studies such as the Cuban Missile Crisis, passage of Great Society legislation, War Powers Act, Gulf War, and Bosnia.

Instructional Objectives

Students will be able to:

Identify and cite primary and secondary source documents;

Close read, annotate, and respond through speaking and writing using a claim, evidence, and reasoning;

Engage in the writing process, edit, and revise;

Participate in structured group discussions, simulations, and debates;

Learn and use content, academic, and social interaction vocabulary;

Develop claim, evidence, reasoning, and counterarguments.

Suggested Activities

Students focus on responding to the following essential questions for this unit: Why are powers divided among different levels of government? What level of government is the most important to me: local, state, tribal, or federal? What level of government is the most powerful: local, state, tribal, or federal?

A. Students examine real-world examples, court cases, and ballot measures. Students identify and analyze a community problem in terms of its causes, effects, and policy implications.

B. Students write to a government body regarding a community problem. Students use choice in deciding the audience. Possibilities include a school board presentation, a letter to a government representative, or a ballot measure for a new law.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, debates, and argument writing.

UNIT VII: The Role of the Media in American Public Life

Students scrutinize the current role of the press in American democracy. Students review the First Amendment's freedom of speech and key U.S. Supreme Court press cases such as Near v. Minnesota (1931), New York Times Co. v. Sullivan (1964) and Hazelwood v. Kuhlmeier (1988). Students discuss the responsibility of citizens to be informed about public issues by using the various media wisely. Students engage with grade-level, intellectually-rich historical content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Government) Content Standards Addressed

12.5 Students summarize landmark U.S. Supreme Court interpretations of the Constitution and its amendments.

1. Understand the changing interpretations of the Bill of Rights over time, including interpretations of the basic freedoms (religion, speech, press, petition, and assembly) articulated in the First Amendment and the due process and equal-protection-of-the law clauses of the Fourteenth Amendment.
2. Analyze judicial activism and judicial restraint and the effects of each policy over the decades (e.g., the Warren and Rehnquist courts).
3. Evaluate the effects of the Court's interpretations of the Constitution in Marbury v. Madison, McCulloch v. Maryland, and United States v. Nixon, with emphasis on the arguments espoused by each side in these cases.
4. Explain the controversies that have resulted over changing interpretations of civil rights, including those in Plessy v. Ferguson, Brown v. Board of Education, Miranda v. Arizona, Regents of the University of California v. Bakke, Adarand Constructors, Inc. v. Pena, and United States v. Virginia (VMI).

12.8 Students evaluate and take and defend positions on the influence of the media on American political life.

1. Discuss the meaning and importance of a free and responsible press.
2. Describe the roles of broadcast, print, and electronic media, including the Internet, as means of communication in American politics.
3. Explain how public officials use the media to communicate with the citizenry and to shape public opinion.

Instructional Objectives

Students will be able to:

Identify and cite primary and secondary source documents;

Close read, annotate, and respond through speaking and writing using a claim, evidence, and reasoning;

Identify reliable sources and bias;

Engage in the writing process, edit, and revise;

Participate in structured group discussions, simulations, and debates;

Learn and use content, academic, and social interaction vocabulary;

Develop claim, evidence, reasoning, and counterarguments.

Suggested Activities

Students focus on responding to the following essential questions for this unit: To what extent are the press and the media fulfilling a watchdog role? Do media outlets provide enough relevant information about government and politics to allow citizens to vote and participate in a well-informed way? How has the Internet revolution impacted journalism, and what are its effects on the coverage of public affairs and current issues?

A. Students examine primary source documents and analyze Supreme Court cases. Students develop media literacy and skills for identifying bias.

B. Students identify a current event/ issue and look at the event through multiple print or media sources. They analyze factual differences, bias, point of view, and conclusions of each source. Students use their evidence to write an opinion editorial on "fake news."

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, debates, and argument/ op-ed writing.

UNIT VIII: Challenges of Democracy

Students review, compare, and contrast the philosophies of major political and economic systems in order to understand the historical context for both democratic and autocratic systems: feudalism, mercantilism, socialism, fascism, communism, capitalism, monarchy, and parliamentary and constitutional liberal democracies. Students discuss the advantages and disadvantages of federal, co-federal, and unitary systems of government. Students then examine, compare, and contrast non-democratic and tyrannical forms of government and the conditions that gave rise to them in certain historical contexts. Students engage with grade-level, intellectually-rich historical content while building a rich language repertoire through reading, writing, speaking, listening, and research based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Government) Content Standards Addressed

12.9 Students analyze the origins, characteristics, and development of different political systems across time, with emphasis on the quest for political democracy, its advances, and its obstacles.

1. Explain how the different philosophies and structures of feudalism, mercantilism, socialism, fascism, communism, monarchies, parliamentary systems, and constitutional liberal democracies influence economic policies, social welfare policies, and human rights practices.
2. Compare the various ways in which power is distributed, shared, and limited in systems of shared powers and in parliamentary systems, including the influence and role of parliamentary leaders (e.g., William Gladstone, Margaret Thatcher).
3. Discuss the advantages and disadvantages of federal, confederal, and unitary systems of government.
4. Describe for at least two countries the consequences of conditions that gave rise to tyrannies during certain periods (e.g., Italy, Japan, Haiti, Nigeria, Cambodia).
5. Identify the forms of illegitimate power that twentieth-century African, Asian, and Latin American dictators used to gain and hold office and the conditions and interests that supported them.
6. Identify the ideologies, causes, stages, and outcomes of major Mexican, Central American, and South American revolutions in the nineteenth and twentieth centuries.
7. Describe the ideologies that give rise to Communism, methods of maintaining control, and the movements to overthrow such governments in Czechoslovakia, Hungary, and Poland, including the roles of individuals (e.g., Alexander Solzhenitsyn, Pope John Paul II, Lech Walesa, Vaclav Havel). 8. Identify the successes of relatively new democracies in Africa, Asia, and Latin America and the ideas, leaders, and general societal conditions that have launched and sustained, or failed to sustain, them.

Instructional Objectives

Students will be able to:

Identify and cite primary and secondary source documents;

Analyze case studies and personal narratives;

Close read, annotate, and respond through speaking and writing using a claim, evidence, and reasoning;

Engage in the writing process, edit, and revise;

Participate in structured group discussions, simulations, and presentations;

Learn and use content, academic, and social interaction vocabulary.

Suggested Activities

Students focus on responding to the following essential questions for this unit: Do citizens have rights that the state must respect; if so, what are they? What is the role of civil dissent and when is it necessary? Why have some revolutions been followed by purges of dissidents, mass arrests of political opponents, murder of “class enemies,” suppression of free speech, abolition of private property, and attacks on religious groups? Why do authoritarian governments spy on their citizens and prevent them from emigrating? Why do they jail or harass critics of their government? Why is only one party allowed in an authoritarian state? Why do ordinary people risk their lives to flee or transform authoritarian states? How do individual countries combat terrorist organizations that do not recognize international norms or boundaries? How can individual citizens or nongovernmental organizations improve civil society? How can multinational alliances work together to combat climate change?

A. Students examine, compare, contrast, and determine the conclusions of primary source documents, personal narratives, and multiple print and media sources documenting historical events.

B. Students prepare a visual presentation and speech using the Universal Declaration of Human Rights. Students detail the background of the Universal Declaration of Human Rights, select a human right in the document, explain its importance, and how it has been and is currently being addressed globally. Lastly, students propose what changes need to occur so that all people receive this right.

C. Students learn close reading skills; examine, compare, and contrast government philosophies; write and give an informational speech according to

rubric criteria; learn and use content, academic, and social interaction vocabulary.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, debates, and informational writing and speaking.

Sacramento City Unified School District

COURSE OF STUDY

FOR

ELD Modern Economics
SXS230

Segment	High School
Length of Course	One Semester
Developed by	Melanie Bean
First Edition	2020

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

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SECTION TWO — COURSE UNITS

ELD Modern Economics

SECTION ONE — GENERAL INFORMATION

COURSE DESCRIPTION

The purpose of ELD (English Language Development) Modern Economics is for English Learners to learn and apply interdisciplinary academic and literacy skills through the meaningful use of language, using the California English Language Development Standards, History/ Social Science Framework, Literacy Standards for History-Social Studies, and California Standards for Career Ready Practice. This course focuses on language and literacy development using content to explore the fundamental principles of economics through the lens of scarcity, investment, growth, employment, competition, protection, entrepreneurship, and markets.

RATIONALE

ELD Modern Economics will provide access to core content within the English Learner newcomer pathway. This course will fulfill the Economics requirement for A-G and graduation within Sacramento City Unified School District while supporting English Language Development.

COURSE GOALS

Upon completion of this course, students will be able to:

- Demonstrate proficiency in meeting the California History/ Social Science standards and framework recommendations for 12th grade Economics;
- Demonstrate proficiency in meeting the California English Language Development 12th grade standards.

COURSE STANDARDS

California History/ Social Science standards and framework recommendations for 12th grade Economics

California English Language Development Standards for Grades 11-12

California English Language Arts Literacy Standards for History- Social Studies for Grades 11-12

California Standards for Career Ready Practice

INSTRUCTIONAL MATERIALS

O'Sullivan, Arthur. **Economics**: **Principles in Action** / Arthur O'Sullivan, Steven M. Sheffrin. Needham, Mass.: Prentice Hall, 2003.

SUPPLEMENTARY MATERIALS:

Council on Economic Education: https://www.councilforeconed.org/

National Endowment for Financial Education: https://www.hsfpp.org/

SUGGESTED AVERAGE TIME FOR COVERING MAJOR UNITS

Unit 1 Fundamental Economic Concepts and Reasoning: 2-4 weeks
Unit 2 The American Market Economy: 4-6 weeks
Unit 3 Government Influence upon the American Economy: 4-6 weeks
Unit 4 Labor Markets: 2-4 weeks
Unit 5 Aggregate Economic Behavior: 2-4 weeks
Unit 6 The Global Economy: 6-8 weeks

TEACHER RESOURCES

Teachers Edition: Economics Principles in Action

RECOMMENDED STUDENT RESOURCES

Student textbooks
Translation devices and bilingual dictionaries

SECTION TWO — COURSE UNITS

All units are designed using the California English Language Development Standards for Grades 11-12 to deliver History/ Social Science Standards

UNIT I: Fundamental Economic Concepts and Reasoning

ELD Modern Economics frames economics through a personal perspective; in other words, students get invested in their study of economics by seeing their place in it, starting with personal budgeting and moving outward to identify their economic place in the world through a multitude of layers. The unit begins by focusing on different kinds of debt, ways of accumulating personal wealth and options for saving money, and budgeting as an example of scarcity. Next, students consider the potential for dynamic growth in a capitalist system, through the reinvestment of profit for future earnings. Students engage with grade-level, intellectually-rich content while building a rich language repertoire through reading, writing, speaking, and listening based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Economics) Content Standards Addressed

12.1: Students understand common economic terms and concepts and economic reasoning.

1. Examine the casual relationship between scarcity and the need for choices.
2. Explain opportunity cost and marginal benefit and marginal cost.
3. Identify the difference between monetary incentives and how changes in incentives cause changes in behavior.
4. Evaluate the role of private property as an incentive in conserving and improving scarce resources, including renewable and nonrenewable natural resources.
5. Analyze the role of a market economy in establishing and preserving political and personal liberty (e.g., through the work of Adam Smith).

Instructional Objectives

Students will be able to:

- Describe and define economic concepts and vocabulary terms outlined in the unit.
- Read and interpret graphs.
- Explain the basic economic question of scarcity in an essay.

- List the types of economic resources and how they are paid—land, labor, capital, and entrepreneur.
- Draw the production possibilities curve from the production possibilities chart, and explain the variety of production choices.
- Explain the meaning of values, goals, and the decision-making process, both personal and economic, and describe their relationship to each other in an essay.
- Examine one’s wants and needs and how they change during a lifetime.
- Solve a given problem by using the step-by-step decision-making process or the decision-making grid.
- Investigate some of the personal economic choices that individuals make.

Suggested Activities

Students focus on answering the following essential questions for this unit: How are resources allocated? What is a market economy?

A. Students define and describe economic concepts, such as scarcity, capitalism, and market economy; read, interpret, and create graphs and charts; list types of economic resources and how they are paid; develop a personal budget; develop a claim, cited evidence, and reasoning for a formal argument essay.

B. Students create a personal budget from an assigned unique economic identity; manage credit, loan, and mortgage debt; build helpful credit; invest and extrapolate accumulated wealth over different time periods; and consider the potential benefits of earning a higher salary by attending educational or vocational institutions. Using this data as evidence, students respond in an argument essay to Adam Smith's assertion that individuals pursuing their own self-interest can also improve society as a whole.

C. Students demonstrate understanding of economic concepts and vocabulary in class and structured, small groups; analyze and interpret data to develop a claim, cited evidence, and reasoning; write an argument essay; learn and use content, academic, and social interaction vocabulary.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, and an argument essay.

UNIT II: The American Market Economy

This unit focuses on comparative economic systems, with a market system characterized by decentralized decision-making on the part of households and individuals. Students learn about incentives, supply and demand, allocation of resources, and open competition. Lastly, students investigate how banks and free markets interact within this system. Students engage with grade-level, intellectually-rich content while building a rich language repertoire through reading, writing, speaking, and listening based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Economics) Content Standards Addressed

12.2 Students analyze the elements of America's market economy in a global setting.

1. Understand the relationship of the concept of incentives to the law of supply and the relationship of the concept of incentives and substitutes to the law of demand.
2. Discuss the effects of changes in supply and/or demand on the relative scarcity, price, and quantity of particular products.

Instructional Objectives

Students will be able to:

- Describe and define economic concepts and vocabulary terms outlined in the unit.
- Read and interpret graphs.
- Explain the basic economic question of scarcity in an essay.
- List the types of economic resources and how they are paid—land, labor, capital, and entrepreneur.
- Draw the production possibilities curve from the production possibilities chart, and explain the variety of production choices.
- Explain the meaning of values, goals, and the decision-making process, both personal and economic, and describe their relationship to each other in an essay.
- Examine one's wants and needs and how they change during a lifetime.
- Solve a given problem by using the step-by-step decision-making process or the decision-making grid.
- Investigate some of the personal economic choices that individuals make.

Suggested Activities

Students focus on answering the following essential questions for this unit: What are key components of the American economic system? How are prices determined? Who determines prices? How do banks and markets function?

A. Students research, compare, and contrast the basic types of economic systems (traditional, command, and market) in terms of what to produce, how to produce, and who shares; advantages and disadvantages; through writing, debates, and visual representation.

B. Students use economic data (for example, figures on unemployment, housing foreclosures, income distribution, or losses in the stock market) to present a case for or against the statement that the American economy has a free financial system through writing, visual representations, and a class debate.

C. Students demonstrate understanding of economic concepts and vocabulary in class and structured, small groups; analyze and interpret data to develop a claim, cited evidence, and reasoning; write an argument essay; prepare evidence for and engage in a debate; learn and use content, academic, and social interaction vocabulary.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, and an argument essay/ debate.

UNIT III: Government Influence upon the American Economy

This unit addresses how the American government is involved in the economy. Students learn to identify the benefits and costs of government influence in the economy in different industries and for different groups of people; consider the legacy of governmental involvement in a mixed economy; analyze and evaluate the extent and impact of government research into energy efficiency, space, medicine, and other investments, examining the distribution of benefits and costs of these investments among different groups; and examine federal budget spending priorities and trace how federal tax dollars are collected and spent. Students engage with grade-level, intellectually-rich content while building a rich language repertoire through reading, writing, speaking, and listening based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Economics) Content Standards Addressed

12.3: Students analyze the influence of the federal government on the American economy.

1. Understand how the role of government in a market economy often includes providing for national defense, addressing environmental concerns, defining and enforcing property rights, attempting to make markets more competitive, and protecting consumers' rights.
2. Identify the factors that may cause the costs of our government actions to outweigh the benefits.
2. Describe the aims of government fiscal policies (taxation, borrowing, spending) and their influence on production, employment, and price levels.
3. Understand the aims and tools of monetary policy and their influence on economic activity (e.g., the Federal Reserve).

Instructional Objectives

Students will be able to:

- Describe major aims of a market economy.
- Explain ways in which people can balance economic rights with economic responsibilities.
- Illustrate the concept of demand in graph form.
- Explain the meaning and concept of demand and supply.
- Understand the relationship between the demand curve and diminishing marginal utility.
- Analyze the three determinants of demand elasticity.
- Understand the purpose of the demand schedule.

- Explain how a free-enterprise economy answers the three economic questions.
- Discuss five major features of free enterprise.
- Explain qualities or characteristics of ethical economic system.
- Demonstrate how prove acts as a rationing device.
- Explain how the combination of supply and demand determine price
- Describe and evaluate the role of government in the free enterprise system.
- Show the relationship between government and business.
- Analyze the relationship between the federal budget deficit and the national debt.

Suggested Activities

Students focus on answering the following essential questions for this unit: How is the American government involved in the economy? How has the American government been involved in the economy in the past? How does the federal budget affect ordinary people? What does it mean to pay taxes? What does it mean to run a deficit? Why is there a Federal Reserve Bank? How does it function?

A. Students understand the role of government in a market economy, identify the aims of fiscal policies and tools, and examine federal budget spending priorities and trace how federal tax dollars are collected and spent through writing, visual representations, and panel discussions.

B. Students research, gather cited evidence and reasoning, and engage in a panel discussion regarding economic regulation proposed by legislators that impact their community (e.g., minimum wage, tax refunds, auto-emission standards). Using data and cost-benefit analysis, students argue both for and against the regulation to better understand the potential economic consequences.

C. Students demonstrate understanding of economic concepts and vocabulary in class and structured, small panels; analyze and interpret data to develop a claim, cited evidence, and reasoning; research and prepare evidence for and engage in a panel discussion; learn and use content, academic, and social interaction vocabulary.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, and an informational research essay.

UNIT IV: Labor Markets

Students apply their understanding of product markets to analyze labor markets, identifying the skills that are in demand and projections of the growth of future jobs and their educational requirements, and the ways in which they can use their school and training to develop their human capital to meet those skill demands. Students engage with grade-level, intellectually-rich content while building a rich language repertoire through reading, writing, speaking, and listening based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Economics) Content Standards Addressed

12.4: Students analyze the elements of the U.S. labor market in a global setting.

1. Understand the operations of the labor market, including the circumstances surrounding the establishment of principal American labor unions, procedures that unions use to gain benefits for their members, the effects of unionization, the minimum wage, and unemployment insurance.
2. Describe the current economy and labor market, including the types of goods and services produced, the types of skills workers need, the effect of rapid technological change, and the impact of international competition.
3. Explain the effects of international mobility of capital and labor on the U.S. economy.

Instructional Objectives

Suggested Activities

Students focus on answering the following essential questions for this unit: What does it mean to work? How does one compete in the labor market? How are wages determined? How and why do workers organize?

A. Students demonstrate understanding of human capital; research labor markets; develop an argument with a claim, cited evidence, reasoning, and counterarguments; and engage in writing, visual representations, and debate.

B. Students research, gather cited evidence and reasoning and participate in a collective bargaining simulation to better understand the competing interests of workers and employers. Students examine the struggles of workers to increase their pay and improve their working conditions, as well as consider the challenges that employers face to

improve productivity, limit costs, and, in the case of for-profit businesses, increase profitability.

C. Students demonstrate understanding of economic concepts and vocabulary in class and structured, small groups; analyze and interpret data to develop a claim, cited evidence, and reasoning; research and prepare evidence for and engage in a simulation; learn and use content, academic, and social interaction vocabulary.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, and an argument essay/ debate.

UNIT V: Aggregate Economic Behavior

Students define gross domestic product (GDP), consumption, investment, savings, unemployment, and inflation to learn that economic growth is a sustained increase in incomes and output over time. Students engage with grade-level, intellectually-rich content while building a rich language repertoire through reading, writing, speaking, and listening based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Economics) Content Standards Addressed

12.5 Students analyze the aggregate economic behavior of the U.S. economy.

1. Distinguish between nominal and real data.
2. Define, calculate, and explain the significance of an unemployment rate, the number of new jobs created monthly, an inflation or deflation rate, and a rate of economic growth.
3. Distinguish between short-term and long-term interest rates and explain their relative significance.

Instructional Objectives

Student will be able to:

- Define the Gross Domestic Product and differentiate between real GDP and money GDP.
- Demonstrate the relationship between GDP and other economic indicators including Standard of Living and Consumer Price Index utilizing charts from newspapers and the textbook.
- In an essay, analyze the cause of unemployment (frictional, structural, or business cycle).
- Explain the difference between M1 and M2.
- Explain how the Federal Reserve uses monetary policies to influence the money supply.
- Define inflation and deflation, and how they are measured.
- Distinguish between demand-pull inflation and cost-push inflation.
- Discuss the effect of inflation and analyze various ways of controlling it.
- Describe how fiscal policy can be used to stabilize the economy.
- Distinguish between expansionary and restrictive fiscal policies.
- Give example of automatic stabilizers and discretionary fiscal policy.
- Explain why taxes are necessary in a market economy.
- Compare the ability to pay principle of taxation.

- Explain the effects of progressive, regressive, and proportional taxes.

Suggested Activities

Students focus on answering the following essential questions for this unit: What is macroeconomics and what does it reveal about the economy? How do data help to tell the story of the economy? How does a cyclical economy function?

A. Students demonstrate understanding of macroeconomics concepts through structured discussions, informational writing, and visual representations.

B. Students research, gather data, and create a visual representation with summary on how a shelter-in-place order effects local, state, and federal economics.

C. Students demonstrate understanding of economic concepts and vocabulary in class and structured, small groups; analyze and interpret data to engage in informational writing and visual representations; learn and use content, academic, and social interaction vocabulary.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, and an informational research essay.

UNIT VI: The Global Economy

Students explore how changes in government policy, technology, information, and the rise of global markets contributed to globalization. Students understand that globalization refers to the faster and freer flow of goods and services, inputs, money, and ideas around the world, as well as the emergence of a global production system used by multinational corporations. Students engage with grade-level, intellectually-rich content while building a rich language repertoire through reading, writing, speaking, and listening based upon the California English Language Development Standards for Grades 11-12.

History-Social Science (Economics) Content Standards Addressed

12.2: Students analyze the elements of America's market economy in a global setting.

1. Analyze how domestic and international competition in a market economy affects goods and services produced, and the quality, quantity, and price of those products.
2. Discuss the economic principles that guide the location of agricultural production and industry, and the spatial distribution of transportation and retail facilities.

12.4: Students analyze the elements of the U.S. labor market in a global setting.

1. Explain the effects of international mobility of capital and labor on the U.S. economy.

12.6: Students analyze issues of international trade and explain how the U.S. economy affects, and is affected by, economic forces beyond United States borders.

1. Identify the gains in consumption and production efficiency from trade, with emphasis on the main products and changing geographic patterns of twentieth-century trade among countries in the Western Hemisphere.
2. Compare the reasons for and the effects of trade restrictions during the Great Depression compared with present-day arguments among labor, business, and political leaders over the effects of free trade on the economic and social interests of various groups of Americans.
3. Understand the changing role of international political borders and Territorial sovereignty in a global economy.
4. Explain foreign exchange, the manner in which exchange rates are determined, and the effects of the dollar's gaining (or losing) value relative to other currencies.

Instructional Objectives

Student will be able to:

- Explain the importance of international trade.
- Describe the meaning of absolute and comparative language.
- Relate the importance of comparative advantage to international trade policies.
- Define the balance of trade and explain the barriers to trade and their effects in the U.S. economy.
- Describe fixed and flexible exchange rate systems.
- Explain why more advanced countries provide foreign aid to less developed countries.
- Describe the barriers to economic development in developing countries.
- Discuss the origins, organizations, and the role of the World Bank.
- Compare the effects of the various barriers to trade, such as tariffs, quotas, subsidies, and monopoly or cartels.
- Compare and contrast the relationship between a change in the balances of trade and a change in the exchange rate.

Suggested Activities

Students focus on answering the following essential questions for this unit: What is globalization? How does globalization affect international and national economies and individuals? Why are there critics of globalization?

A. Students demonstrate understanding of globalization through collaborative group activities, informational writing, visual representations, and speeches.

B. Students create a slide presentation to trace how that one consumer item has participated in the global economy: origins of the item's raw materials, where it was assembled, the headquarters of the company that produced the item, all the countries that item has passed through, and then its sale in the U.S. Students individually give an oral presentation to the class.

C. Students demonstrate understanding of economic concepts and vocabulary in class, structured, small groups, and individually; research and use cited evidence to create a media slide presentation; give an oral presentation using appropriate public speaking techniques; learn and use content, academic, and social interaction vocabulary.

Suggested Assessment

Students demonstrate proficiency of grade level history and ELD standards through initial goal-setting, formative and summative assessments, personal reflection, and an informational visual presentation.

Sacramento City Unified School District

COURSE OF STUDY

FOR

Latin IV
GLS009 / GLS010

Segment	High School
Length of Course	One Year
Developed by	*Damian Harmony*
First Edition	2020

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

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"The Sacramento City Unified School District is committed in all of its activities, policies, programs, and procedures to provide equal opportunity for all to avoid discrimination against any person regardless of ethnicity, gender, religion, national origin, disability, marital status, or age."

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LATIN, LEVEL IV

SECTION ONE — GENERAL INFORMATION

COURSE DESCRIPTION

Students will continue exploring Latin at the advanced level. This course is designed for the students who have completed 3rd Level Latin with a grade of "C" or better. Students will no longer be directly taught grammar, but use what they have learned through practice in various translations. This program provides a few opportunities to learn very specific periphrastic phrases, but on the whole, they have completed the totality of their grammar in Latin 3. Projects will emphasize student creations utilizing proper Latin grammar, and exploring the use of high-frequency vocabulary for their translations. The projects include writing a graphic novel based on Livy's *Ab Urbe Condita*, a fashion magazine using Ovid's *Ars Armatoria*, and developing playing cards (akin to Magic the Gathering/Pokémon) using Caesar's *De Bello Gallico*, to explore specific people, places, events, and tribes written about in Caesar's account. Students will explore thematic use of grammar and vocabulary, and political considerations in Caesar's writings. In Livy's works, they will explore the historiography of Rome through the discussions Livy has regarding peace, war, virtue, and cunning. In Ovid, they will learn about youth culture in Rome, and how said culture investigates its own customs when they go courting. In Plautus, students will analyze the themes of property rights, a slave's rights and expectations of safety, and how socially-mobile society was in early Rome; they will also learn about the various uses of humor in a slave republic. Students will learn to translate these writings at sight, instead of with a vocabulary list or commentary. Through these writings, students will develop a greater understanding about Roman provincial history, as well as the ancient mythology that Romans took as fact, and the culture and distractions one might find in Rome proper. They will familiarize themselves with important historical figures, including Caesar, Ariovistus, Ambiorix, Pullo, Aeneas, Numitor, Romulus, Numa, and Tullus Hostilius. This course will help students contribute to preserving the integrity of the language and encourage studies in the classics at the college level. Students will learn that Latin is a subtle, elegant, and powerful language that will enrich their abilities in English.

RATIONALE

Until recently, Latin was a staple of any Western curriculum. From medieval times to America's founding, no education was considered complete without it. Instruction usually began at a young age; by graduation, students could recite Virgil or Cicero with ease. Latin is frequently credited for generic benefits that come with learning any second language.

Instead of instructing language merely as a vehicle to convey meaning or intent, Latin compels students to dive deeper into the architecture of language itself. Words have an abstract character comparable to mathematical symbols, but through Latin they have anatomy.
Latin brought forth the Romantic (i.e., "Roman") languages: French, Spanish, Italian, Portuguese, Romanian, etc. English is like a step-child, claiming her Latin heritage through French. However, the resemblance is striking: roughly 40 percent of the English vocabulary is comprised of Latin-based words. This percentage increases the more syllables you add. The structural similarities are also considerable.

COURSE GOALS

Upon completion of this course, students will be able to:

This Latin IV course is designed to give students the experiences needed to do advanced-Latin translations at the college level. The course's goals are to develop the students' abilities to translate the required passages from Caesar's *De Bello Gallico*, Ovid's *Ars Amatoria*, Vergil's *Aeneid*, Plautus' *Pseudolus*, and Livy's *Ab Urbe Condita* into English as literally as possible, to help them understand the context of the written passages (including the political, historical, literary, and cultural background of each author and text), and to help them understand the reasons behind the particular style of writing and the rhetorical devices employed. The course should also help students to be successful in analyzing Latin passages to understand how and why the author uses the language in a particular way and the effects he is hoping to produce. Students will learn to analyze the text and draw their own logical conclusions. This course should give students tools to read Latin prose and poetry aloud and with accurate comprehension and appreciation. For the Vergil text, students will learn dactylic hexameter and how it is used to enhance the text and create effect, and students will learn to scan and read the poetry using dactylic hexameter to further understand the use of rhetoric.

Students will literally translate the assigned texts (Caesar and Vergil), additional weekly sight-translations (in addition to Caesar and Vergil, prose and poetry consisting of Horace, Juvenal, Persius Flaccus, Catullus, Ovid, Martial, Livy, Cicero, and Pliny the Younger), and answer questions about those translations on a nearly-daily basis. This will be the main focus of the course; it's why we are here.
Students will write one essay per unit (typically once a month), analyzing themes in each book such as War and Roman Conceptions of Masculinity (Caesar), Historiography and Mass Appeal (Caesar), Humans and the Gods (Vergil), Roman Values (Vergil and

Caesar), Views of Non-Romans (Vergil and Caesar), Leadership (Caesar and Vergil), and Literary Style (Caesar and Vergil).
Students will also be required, once per semester, to produce a presentation (one for Caesar, one for Vergil). They will use their knowledge of the text and the authors to create a multimedia class presentation on some historical event or cultural theme related to the readings.

COURSE STANDARDS

This course will adhere to all the national standards set forth for classics learning, per the American Classical League classical language learning standards.
COMMUNICATION Goal 1 Communicate in a Classical Language
Standard 1.1 Students read, understand, and interpret Latin or Greek.
Standard 1.2 Students use orally, listen to, and write Latin or Greek as part of the language learning process.

CULTURE Goal 2 Gain Knowledge and Understanding of Greco-Roman Culture
Standard 2.1 Students demonstrate an understanding of the perspectives of Greek or Roman culture as revealed in the practices of the Greeks or Romans.
Standard 2.2 Students demonstrate an understanding of the perspectives of Greek or Roman culture as revealed in the products of the Greeks or Romans.

Goal 3 CONNECTIONS Connect with Other Disciplines and Expand Knowledge
Standard 3.1 Students reinforce and further their knowledge of other disciplines through their study of classical languages.
Standard 3.2 Students expand their knowledge through the reading of Latin or Greek and the study of ancient culture.

Goal 4 COMPARISONS Develop Insight into Own Language and Culture
Standard 4.1 Students recognize and use elements of the Latin or Greek language to increase knowledge of their own language.
Standard 4.2 Students compare and contrast their own culture with that of the Greco-Roman world.

Goal 5 COMMUNITIES Participate in Wider Communities of Language and Culture
Standard 5.1 Students use their knowledge of Latin or Greek in a multilingual world.
Standard 5.2 Students use their knowledge of Greco-Roman culture in a world of diverse cultures.

INSTRUCTIONAL MATERIALS

Students will read *De Bello Gallico, Ars Amatoria, Ab Urbe Condita,* and *Aeneid* in English, and demonstrate knowledge of the major themes, events, characters, and relevant historical background. Students will also receive handouts and articles that complement their reading, and which are designed to enrich their understanding of the primary sources. Each quiz and the comprehensive final exam will include questions concerning the texts in English as well as in Latin, and all essays must include analysis drawn from the readings in English.

TEXTBOOKS

Caesar – Mueller, Hans-Freidrich. Sprague, Donald, ed. *Caesar: Selections from his Comentarii De Bello Gallico*. 2012.

Vergil – Weiden, Barbara. Buchholz, Bridget, ed. *Vergil's Aeneid: Selected Readings from Books 1, 2, 4, and 6*. 2012.

SUPPLEMENTARY MATERIALS:

Other materials which the district has not offered to pay for that will include the same level of notes and scaffolding as the above publications. Luckily, Latin texts are largely public domain. Livy, Catullus, Ovid, Plautus, Caesar, Vergil, Horatius, Lucretius, Augustus, and Martial, can all be used in this course.

SUGGESTED AVERAGE TIME FOR COVERING MAJOR UNITS

4 weeks: Read Plautus' *Pseudolus* Act 1
Explore concepts of slaves' expectations, social norms, and humor, through this play.
8 weeks: Read Caesar's *De Bello Gallico* Books 1, 4, 5, and 6.
Explore concepts of virtue, heroism, prudence, duty, and trust through these books
12 weeks: Read selected books from 1-45 of Livy's *Ab Urbe Condita*
Explore concepts of cunning, virtue, ambition, peace, religion, and agriculture through these books
4 weeks: Read excerpts from Ovid's *Ars Amatoria*
Explore concepts of romantic love, marriage, courtship, and attraction through these books

Remaining and intercallory Time: Discuss Aeneid in its entirety and the historical context for the Aeneid, Vergil, and Epic writing.
Translate *Aeneid* Book 1.1-209, 1.418-440, 1.494-578, Read *Aeneid* Book 1.
Discuss Livy's version of Aeneas' wanderings, and the different goals of each writer. Discuss specific rhetorical terms used in the *Aeneid*, including specific metrical devices.
Translate *Aeneid* Book 2.40-56, 2.201-249, 2.268-297, 2.559-620, Read *Aeneid* Book 2.
Review and Test Book 2
Examine the map of Aeneas' wanderings, discuss psychology of Dido, continue weekly scansion exercises, continue work with other verse and meter exercises.
Translate *Aeneid* Book 4.160-218, 4.259-361, 4.659-705, Read *Aeneid* Book 4.
Review and Test Book 4
Examine Roman and Greek ideas of the underworld and afterlife, continue weekly scansion exercises, continue work with other verse and meter exercises.
Translate *Aeneid* Book 6.295-332, 6.384-425, 6.450-476, 6.847-899. Read Book 6.

TEACHER RESOURCES

As above: Other materials which the district has not offered to pay for that will include the same level of notes and scaffolding as the above publications. Luckily, Latin texts are largely public domain. Livy, Catullus, Ovid, Plautus, Caesar, Vergil, Horatius, Lucretius, Augustus, and Martial, can all be used in this course

RECOMMENDED STUDENT RESOURCES

As above: Other materials which the district has not offered to pay for that will include the same level of notes and scaffolding as the above publications. Luckily, Latin texts are largely public domain. Livy, Catullus, Ovid, Plautus, Caesar, Vergil, Horatius, Lucretius, Augustus, and Martial, can all be used in this course. The links to these sources sometimes change, as people change domains. However, thelatinlibrary.com often has some of the best, clearest, versions of the actual primary sources.

SECTION TWO — COURSE UNITS

All units may be broken up into smaller chunks, and moved around to better aid students in comparing literatures and literary usage

CAESAR UNIT: From the Rhine, to the Gauls, 'til the Roman Republic Falls

Discuss important background information on Caesar and the Gallic Wars; Translate *De bello Gallico* 1.1-1.7, Read Book 1 of *De bello Gallico*
Discuss important background information on Caesar's reasons for staying in Gaul, Gallic culture, Briton culture, and the Roman navy.
Read *De bello Gallico* 4.1-4.23, Translate *De bello Gallico* 4.24 - 4.36.1, Read Book 4 of *De bello Gallico*
Discuss important background information on Gallic tribes, Ambiorix, Roman camps, and the Roman army.
Read *De bello Gallico* 5.1-5.23, Translate *De bello Gallico* 5.24-5.48
Discuss important background information on Bronze Age religion, cultural assumptions in the ancient world, and the Druids
Read *De bello Gallico* 6.1-12, Translate *De bello Gallico* 6.13-6.20, Read Book 6 of *De bello Gallico*

Standards Addressed

Standard Goals 1-4

Instructional Objectives

Students will be able to:

Students read, understand, and interpret Latin or Greek
Students use orally, listen to, and write Latin or Greek as part of the language learning process
Students demonstrate an understanding of the perspectives of Greek or Roman culture as revealed in the practices of the Greeks or Romans.
Students demonstrate an understanding of the perspectives of Greek or Roman culture as revealed in the products of the Greeks or Romans.
Students reinforce and further their knowledge of other disciplines through their study of classical languages.
Students expand their knowledge through the reading of Latin or Greek and the study of ancient culture.

Students recognize and use elements of the Latin or Greek language to increase knowledge of their own language.
Students compare and contrast their own culture with that of the Greco-Roman world.

Suggested Activities

There will be a tremendous focus on translation and understanding the contexts of what we translate.
Students will be required to translate at home daily, in addition to daily translations in class. Parsing will continue in class as well.
Most translations in class will be in cohorts – as groups do better than individuals when trying to understand the meanings behind the meanings. Tuesdays are reserved for weekly quizzes, which will include scansion, parsing, and text analysis. Further practice of these aspects will be done at the first fifteen minutes of each class. Mondays will be scansion, Wednesdays will be short-answer text/theme analysis, Thursdays will be parsing, and Fridays will be sight-translating and reading both prose and poetry aloud

Suggested Assessment

Weekly Quizzes: a blend of grammar, high-frequency vocabulary, and Roman culture assessments based on material presented in the class and translations
Latin Action Cards Project: Artistic project designed to engage the students' learning and combine their understanding of Latin grammar, vocabulary, and Roman culture to create a set of unique playing cards about various leaders, personalities, tribes, divisions, locations, events in the Gallic Wars.
Graphic Novel Project: Artistic project designed to engage the students' knowledge of prose composition, grammar, vocabulary, and Roman historiography.
For *De Bello Gallico* and *Aeneid* – write a 10-12 page formal essay comparing and contrasting themes of either propaganda, virtue, or foreign-vs-domestic dynamics. Use of the texts is mandatory.

VERGIL UNIT: Propaganda or Poetry? Why decide?

Discuss Aeneid in its entirety and the historical context for the Aeneid, Vergil, and Epic writing. Begin weekly scansion exercises, discuss dactylic hexameter and other terms dealing with meter and verse.
Translate *Aeneid* Book 1.1-209, 1.418-440, 1.494-578, Read *Aeneid* Book 1.
Discuss Livy's version of Aeneas' wanderings, and the different goals of each writer. Discuss specific rhetorical terms used in the *Aeneid*, including specific metrical devices.
Translate *Aeneid* Book 2.40-56, 2.201-249, 2.268-297, 2.559-620, Read *Aeneid* Book 2.
Examine the map of Aeneas' wanderings, discuss psychology of Dido, continue weekly scansion exercises, continue work with other verse and meter exercises.
Translate *Aeneid* Book 4.160-218, 4.259-361, 4.659-705, Read *Aeneid* Book 4.
Examine Roman and Greek ideas of the underworld and afterlife, continue weekly scansion exercises, continue work with other verse and meter exercises.
Translate *Aeneid* Book 6.295-332, 6.384-425, 6.450-476, 6.847-899. Read Book 6.

Standards Addressed

Standard Goals 1-5

Instructional Objectives

Students will be able to:

Students read, understand, and interpret Latin or Greek
Students use orally, listen to, and write Latin or Greek as part of the language learning process
Students demonstrate an understanding of the perspectives of Greek or Roman culture as revealed in the practices of the Greeks or Romans.
Students demonstrate an understanding of the perspectives of Greek or Roman culture as revealed in the products of the Greeks or Romans.
Students reinforce and further their knowledge of other disciplines through their study of classical languages.
Students expand their knowledge through the reading of Latin or Greek and the study of ancient culture.
Students recognize and use elements of the Latin or Greek language to increase knowledge of their own language.
Students compare and contrast their own culture with that of the Greco-Roman world.
Students use their knowledge of Latin or Greek in a multilingual world.
Students use their knowledge of Greco-Roman culture in a world of diverse cultures.

Suggested Activities

There will be a tremendous focus on translation and understanding the contexts of what we translate.
Students will be required to translate at home daily, in addition to daily translations in class. Parsing will continue in class as well.
Most translations in class will be in cohorts – as groups do better than individuals when trying to understand the meanings behind the meanings. Tuesdays are reserved for weekly quizzes, which will include scansion, parsing, and text analysis. Further practice of these aspects will be done at the first fifteen minutes of each class. Mondays will be scansion, Wednesdays will be short-answer text/theme analysis, Thursdays will be parsing, and Fridays will be sight-translating and reading both prose and poetry aloud

Suggested Assessment

Weekly Quizzes: a blend of grammar, high-frequency vocabulary, and Roman culture assessments based on material presented in the class and translations
Scansion Practice: Students will pull apart and analyze selected lines from Vergil, to fully understand dactylic hexameter and its usage in current day poetry and hip-hop.
Graphic Novel Project: Artistic project designed to engage the students' knowledge of prose composition, grammar, vocabulary, and Roman historiography.
For *De Bello Gallico* and *Aeneid* – write a 10-12 page formal essay comparing and contrasting themes of either propaganda, virtue, or foreign-vs-domestic dynamics. Use of the texts is mandatory.

PLAUTUS UNIT: PLAYING WITH PLAYS

Read Plautus' *Pseudolus* Act 1
Explore concepts of slaves' expectations, social norms, and humor, through this play.

Standards Addressed

Standard Goals 1-5

Instructional Objectives

Students will be able to:

Students read, understand, and interpret Latin or Greek
Students use orally, listen to, and write Latin or Greek as part of the language learning process
Students demonstrate an understanding of the perspectives of Greek or Roman culture as revealed in the practices of the Greeks or Romans.
Students demonstrate an understanding of the perspectives of Greek or Roman culture as revealed in the products of the Greeks or Romans.
Students reinforce and further their knowledge of other disciplines through their study of classical languages.
Students expand their knowledge through the reading of Latin or Greek and the study of ancient culture.
Students recognize and use elements of the Latin or Greek language to increase knowledge of their own language.
Students compare and contrast their own culture with that of the Greco-Roman world.
Students use their knowledge of Latin or Greek in a multilingual world.
Students use their knowledge of Greco-Roman culture in a world of diverse cultures.

Suggested Activities

Reading Play aloud in the proper meter and verse: Students will form a reader's theater, or radio play format, reading the play aloud with proper intonations, respect to the meters used, and pronunciation, necessary to dramaticize the play.

Fashion Magazine Project: Artistic and writing project designed to engage the students' knowledge of urban Roman culture, focusing on themes having to do with romance, courtship, and beauty, using appropriate grammar and vocabulary.

Suggested Assessment

Weekly Quizzes: a blend of grammar, high-frequency vocabulary, and Roman culture assessments based on material presented in the class and translations
Parsing Practice: Students will pull apart and analyze selected lines from Plautus, taking what they know of Imperial Latin grammar, and applying it to archaic Latin grammar
For *Pseudolus* – write a 4-5 page formal essay, analyzing the need for a play that challegnes the culture of slave-and-master interrelations, and allows everything to return to status quo at the end. Students must use quotes from the play, analyze character motives, and contextualize the interplay between Greek and Roman ideologies/biases shown in the play.