Middle School
PHENOMENA

CANGSS

CA NGSS 3D
STEMscopes™
K-12 SCIENCE

STEMscopescalifornia.com

Coherence means that student learning modules—units (segments), chapters (scopes), and lessons (hands-on exploration)—logically flow between one another and also build upon each other to form a sequence of student missions (performance expectations).

Our approach to coherence allows for **student choice** in learning progression and gives students a framework to link the application of the **three dimensions** to real-world phenomena using prior knowledge and new understandings and abilities.

STEMscopes' segments are coherent on two levels: lesson design via the **5E model** and **layered phenomena**—anchoring, investigative, and everyday. Each segment begins with an anchoring phenomena event, an anchoring phenomena driving question, and a mission action plan. Together, these drive the instructional focus of the scopes within a segment, while students explore a variety of phenomena and learn to apply their knowledge and abilities.

Each segment's scopes are tied to investigative and everyday phenomena, forming a bridge that builds students' knowledge progressively toward the segment's anchoring phenomena and mission action plan.

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STEMscopes CA NGSS 3D K-12 SCIENCE™

segment coherence overview

The STEMscopes segment coherence flowchart shown below illustrates how a segment (unit) and its scopes (chapters) are organized and work together. Each segment begins with an anchoring phenomena event, an anchoring phenomena driving question, and a mission action plan (performance expectation), which drive the instructional focus of each scope. Scopes (chapters) are tied to investigative and everyday phenomena, forming a bridge that builds students' knowledge progressively toward the segment's anchoring event and driving question, and culminate in the mission action plan.

7th grade segment 1

ORGANISMS & NONLIVING THINGS ARE MADE OF ATOMS

SCOPE: HUMAN DEPENDENCE ON NATURAL RESOURCES

start here

ANCHORING PHENOMENA EVENT

People running a marathon compete for natural resources.

STUDENT QUESTIONING

Teacher guides students through inquiry.

ANCHORING DRIVING QUESTION

Do soil samples taken from a newly discovered planet provide enough evidence of life and natural resources to support future explorations of this planet?

segment (unit)

scope (chapter)

INVESTIGATIVE PHENOMENA

Where are natural resources located on Earth?

EXPLORE (ACTIVITY) It's Not Renewable? So What?

EVERYDAY PHENOMENA

Humans have an effect on the supply of nonrenewable resources available.

EXPLORE (RESEARCH) How Was It Formed? Where Is It Located? How Do We Use It?

EVERYDAY PHENOMENA

Geological events affect the distribution of natural resources.

EXPLORE (ENGINEERING SOLUTION) Use and Consequences Game

EVERYDAY PHENOMENA

There are consequences of human behavior and use of natural resources.

EXPLORE (TUVA) Earth's Overdrawn Account

EVERYDAY PHENOMENA

The world's population affects the production and consumption of fossil fuels.

DCI COMPONENT IDEAS Humans depend on Earth's natural renewable and nonrenewable resources. These resources are distributed unevenly around the planet as a result of past and current geologic processes.

APPLICATION Students simulate cause-and-effect relationships and make predictions about human use of nonrenewable natural resources.

APPLICATION Students research nonrenewable natural resources and explain that the distribution of Earth's resources is due to geologic events.

APPLICATION Students play a game using cause-and-effect relationships to predict the resource most vulnerable to a consequence, based on how the resource is used.

APPLICATION Students create dot plots, line graphs, and bar charts to explore changes in world population, production of fossil fuels, and the consumption of fossil fuels.

CER During this scope, students explore the investigative phenomena, "Where are natural resources located on Earth?" Students will apply what they have learned and how their thinking has changed to construct a scientific explanation that explains why oil is found in the Middle East but not in Hawaii.

MISSION LOG CONNECTS TO ADDITIONAL SCOPES IN SEGMENT

Competition in Ecosystems, Organism Interactions in Ecosystems, Structure of Matter, Changes in Energy on the Molecular Level, Heat and Matter

MISSION ACTION PLAN

The student's mission is to analyze soil samples from a newly discovered planet and determine the possibility of life and beneficial resources that justify future explorations. The student will present the findings to Congress and persuade legislators to continue funding missions to this planet.

physical science segment 6

WAVES & THEIR APPLICATIONS IN TECHNOLOGIES & INFORMATION TRANSFER

SCOPE: PROPERTIES OF VISIBLE LIGHT

start here

ANCHORING PHENOMENA EVENT

Students are learning to use Morse code to communicate.

STUDENT QUESTIONING

Teacher guides students through inquiry.

ANCHORING DRIVING QUESTION

How are different types of waves used in technology and communication applications?

segment (unit)

scope (chapter)

INVESTIGATIVE PHENOMENA

What are the properties of visible light?

EXPLORE (ACTIVITY) Simulating Light

EVERYDAY PHENOMENA

We can model the light path between transparent materials and the frequency of different colors of light.

EXPLORE (ACTIVITY) What Color Is That?

EVERYDAY PHENOMENA

Colored lights appear different when shining on different colored objects.

EXPLORE (SCIENTIFIC INVESTIGATION) Interactions of Light Waves

EVERYDAY PHENOMENA

Visible light interacts with materials differently, causing reflection, absorption, or transmission.

EXPLORE (ENGINEERING SOLUTION) Lights Out

EVERYDAY PHENOMENA

A window treatment can be designed to block outside light.

EXPLORE (TUVA) How Do Different Materials Affect Light Waves?

EVERYDAY PHENOMENA

Different materials affect the velocity and direction of light waves.

DCI COMPONENT IDEAS

When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.

APPLICATION

Students use a simulation program to model the light paths between transparent materials and the frequencies of different colors of light.

APPLICATION

Students explore how colored lights can appear different when shining on different-colored objects.

APPLICATION

Students investigate interactions of visible light waves with various materials, such as reflection, absorption, and transmission.

APPLICATION

Students design and construct a window treatment that functions as a stylish and effective method of blocking outside light.

APPLICATION

Students create bar charts to explore relationships between various mediums and the refraction of light.

CER

During this scope, students discover the properties of visible light. The student will examine a scenario where four friends test the effects of using goggles to see a chart under water. The student will analyze the results from the friends' test and write a scientific explanation that describes the differences the friends found between wearing and not wearing goggles under water.

MISSION LOG CONNECTS TO ADDITIONAL SCOPES IN SEGMENT

Introduction to Properties of Waves, Modeling Waves through Various Mediums, Modeling Light Waves, Digital vs. Analog Signals

MISSION ACTION PLAN

The student's mission, in the role of a salesperson, is to pitch a new product on the popular television show Making Life Easier. The student will design a device that uses light waves to communicate. The sales pitch will include a visual, as well as an explanation, of how the device works, how it would make life easier, and the advantages of using light waves.

FIGURING OUT

introduction to STEMscopes PHENOMENA

Serving as the context for both scientists and engineers in their work, phenomena are predicted through scientific knowledge, which is then used to create solutions to real-world problems. STEMscopes centers STEM education around three layers of phenomena—anchoring, investigative, and everyday. Together, these form a coherent storyline supported by student-driven daily experiences and inquiry and evaluated by claim-evidence-reasoning assessments. Centering education around phenomena pushes students to move from learning about topics to figuring out why and how things happen, so they become scientists and engineers in the classroom.

LEARNING

6th Grade

PHENOMENA SEGMENT 1

Systems & Subsystems in Earth & Life Science

Mission Story: As Earth scientists, students have been asked to present on the Earth's climate to a group of life scientists gathered to discuss global climate change. The presentation should include a comparison of Earth systems, such as the water cycle or climate, and living systems, such as a cell or an organism. They are to provide a diagram of the proposed model and an evaluation of how well the model compares the two systems.

Anchoring Event: A system is made up of various parts that work together for a specific purpose. Models of systems, whether of living systems or Earth systems, should include many parts that work together.

The students will view a video of a car engine running and participate in a teacher-led discussion about how the engine's parts act as a system. The teacher guides the discussion toward how models of systems help us understand similarities and differences between Earth and living systems.

Anchoring Phenomena Driving Question: How can models of systems help determine similarities and differences between Earth systems and living systems?

Cells

Investigative Phenomena: What is the smallest thing that can be considered living?

Everyday Phenomena:

An organism is either unicellular or multicellular.

All living things are made of cells.

Anatomy of a Cell

Investigative Phenomena: How can a single-celled organism sustain life?

Everyday Phenomena:

A plant cell is different from an animal cell.

Different parts of a cell contribute to how a cell functions and stays healthy.

Bodies and Systems

Investigative Phenomena: Why can you not function properly without one of your body systems?

Everyday Phenomena:

Human subsystems interact to carry out the functions of the human body.

Systems may interact with other systems and can be part of a larger complex system.

All body systems are important to the functioning of the organism as a whole.

One minute of exercise can affect a human's pulse rate.

The Water Cycle

Investigative Phenomena: How does water cycle through Earth's systems?

Everyday Phenomena:

Water cycles through Earth's systems through processes of evaporation, condensation, precipitation, accumulation, percolation, and runoff.

Water cycles through Earth's systems driven by energy from the Sun and the force of gravity.

Influences on Weather and Climate

Investigative Phenomena: What causes locations on Earth to have different climates?

Everyday Phenomena:

Unequal heating and rotation of Earth cause patterns of atmospheric circulation that determine regional climates such as those of equatorial and polar areas.

Wind and land masses affect ocean surface currents.

Ocean currents influence the climate of landmasses.

PHENOMENA SEGMENT 2

Earth System Interactions Cause Weather

6th Grade

Mission Story: To meet the needs of Olympic athletes traveling between events in different climates, students are asked to design a portable structure that will keep them cool in hot climates and warm in cool climates. The structure must be easy to move between venues, and it cannot depend on electric or battery power. The new product proposal must include a model showing how thermal energy transfer affects the climate in two different California cities, a labeled diagram of the proposed product, and an explanation of how the product will work.

Anchoring Event: Thermal energy transfers through conduction, convection, and radiation. Solar radiation and convection currents in the ocean influence California's varying climates.

Students will view a video of wind currents around the world and participate in a teacher-led discussion about how wind currents affect water and transfer energy, as in a hurricane. The teacher guides the discussion to how models of thermal energy transfer help us understand the different kinds of weather in California.

Anchoring Phenomena Driving Question: How can models of thermal energy transfer help us understand the different kinds of weather in California?

Ocean Currents

Investigative Phenomena: How does the ocean influence weather and climate?

Everyday Phenomena:

Ocean currents are influenced by surface winds, temperature, salinity, the Earth's rotation, and ocean tides.

Ocean currents, warm currents, and cold currents affect weather and climate patterns.

Thermal Energy Transfer

Investigative Phenomena: What types of materials keep substances warm and cold?

Everyday Phenomena:

Thermal energy moves due to conduction, convection, and radiation.

Different types of matter affect thermal energy transfer in a designed system.

We can apply scientific ideas, such as volume of matter, to design, construct, and test a device that keeps medicine cold.

Temperature is a measure of the average kinetic energy of particles of matter.

Kinetic Energy

Investigative Phenomena: What is the relationship of mass and speed to kinetic energy?

Everyday Phenomena:

Objects with greater mass have greater kinetic energy.

Objects with greater speed have greater kinetic energy.

We can use what we know about kinetic energy to design devices to keep us safer.

Energy Transfer and Temperature

Investigative Phenomena: How does the matter and mass of a substance affect the transfer of energy?

Everyday Phenomena:

Different liquids change temperatures at different rates after ice has been added to them.

The amount of matter affects the rate at which the matter changes temperature when exposed to heat.

The transfer of energy is affected when there is a change in the environment.

The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.

6th Grade

PHENOMENA SEGMENT 3

Causes & Effects of Regional Climates

Mission Story: Every March, sled dogs race from Anchorage to Nome, Alaska in the Iditarod, running over ice and snow in winter weather conditions. Groups in Saudi Arabia, Oman, and Yemen want to hold a similar race in the Arabian Desert, with sled dogs racing over sand dunes. Students will develop and present a plan for a desert sled dog race.

Anchoring Event: Climate is affected by a variety of conditions, including latitude, proximity to the ocean, ocean currents, and elevation. Organisms adapt to their surroundings to survive in a specific climate.

The students view a video of an albino deer and then participate in a teacher-led discussion about how the deer has an inherited mutation that may affect its ability to survive and reproduce in certain climates. The teacher guides the discussion toward how the climate in different regions affects all organisms living there.

Anchoring Phenomena Driving Question: Why is the climate different in different regions of the planet, and how do the differences in climate affect organisms?

Reproduction in Plants and Animals

Investigative Phenomena: What characteristics do plants and animals have that increase their chances of reproduction?

Everyday Phenomena:

The spawning behaviors of fish affect their reproduction success.

Plants and animals develop various adaptations to help their species survive.

Certain parts of a flower attract pollinators better than other parts.

Growth of Organisms

Investigative Phenomena: Do environmental or genetic factors affect the growth of organisms most?

Everyday Phenomena:

Environmental and genetic factors affect a plant's survival.

Environmental factors and genetic traits affect the growth of organisms.

Sensory Receptors

Investigative Phenomena: How does your body know how to respond to something happening inside or outside your body?

Everyday Phenomena:

We can test your five senses.

Different scents can trigger memory responses.

There is a relationship between sensory receptors and the storage and usage of sensory information by organisms.

Inheritance and Genetic Variation

Investigative Phenomena: How can siblings look so different if they share the same parents?

Everyday Phenomena:

Siblings do not look identical to each other due to a variety of inherited and mixed traits.

Dominant and recessive alleles affect traits.

We can predict possible genetic outcomes.

We can design prototypes of predicted offspring from asexual reproduction.

Predicting Weather

Investigative Phenomena: What causes changes in weather conditions?

Everyday Phenomena:

Motions and complex interactions of air masses result in changing weather conditions.

We can use computer-generated weather models and statistical data to answer scientific questions, such as the probability that a hurricane will make landfall at a specific location.

We can model air pressure, condensation, and heat transfer to predict phenomena using cause-and-effect relationships.

Landforms have an effect on weather and can cause rain shadows.

We can use maps to collect data and identify weather patterns.

PHENOMENA SEGMENT 4

Effects of Global Warming on Living Systems

6th Grade

Mission Story: Students have been invited to the California Water Allocation Summit, as residents of Santa Clara Valley. A reduction in the water supply is being proposed, as there is no longer enough water to keep up with current usage. Students will participate in a debate with other groups to present their arguments for why the water supply to Santa Clara should not be reduced.

Anchoring Event: Global climate change has had an impact on the water supply in California.

The students view a video of a swan swimming in an oil spill. They participate in a teacher-led discussion about how oil spills caused by humans affect the organisms that live in the area and how fossil fuels contribute to climate change. The teacher guides the discussion to the impact of global climate change on the water supply in California.

Anchoring Phenomena Driving Question: Has global climate change affected the water supply in California?

Human Impact on the Environment

Investigative Phenomena: How does our use of natural resources affect the environment?

Everyday Phenomena:

The human population affects air pollution.

Adding carbon dioxide to the ocean alters the ocean's habitat and affects its organisms.

We can design a system to monitor human effects on a natural habitat.

Human Activities and Global Climate Change

Investigative Phenomena: What factors have caused the rise in global temperatures over the past century?

Everyday Phenomena:

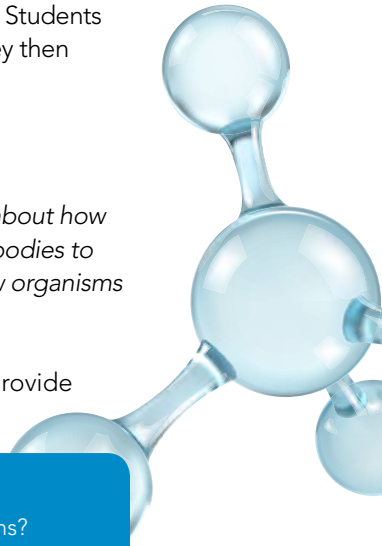
We can model the greenhouse effect and impacts of global warming on our oceans.

Human activity contributes to the causes of global warming.

7th Grade

PHENOMENA SEGMENT 1

Organisms & Nonliving Things Are Made of Atoms



Mission Story: A Rover mission to a newly discovered planet has produced three different soil samples. Students analyze these samples to determine the possibility of life and any resources that could be beneficial. They then create an infographic to persuade Congress to fund future missions to this planet.

Anchoring Event: People running a marathon compete for natural resources.

Students view a video of people competing in a marathon. They participate in a teacher-led discussion about how the runners are competing for resources like space and water, while heat is being transferred from their bodies to the atmosphere through sweat and respiration. The teacher then generalizes the concept to discuss how organisms compete for natural resources to survive, and applies it to the driving question.

Anchoring Phenomena Driving Question: Do soil samples taken from a newly discovered planet provide enough evidence of life and natural resources to support future explorations of this planet?

Competition in Ecosystems

Investigative Phenomena: How does the amount of resources in an ecosystem affect populations?

Everyday Phenomena:

Biotic and abiotic factors can drive the relationship between organisms and what combinations of organisms exist in an ecosystem.

Interacting populations rely on limited resources within an ecosystem.

Organism Interactions in Ecosystems

Investigative Phenomena: How can a change to the population of one species affect an entire ecosystem?

Everyday Phenomena:

Changes within the components of an ecosystem have an effect on the ecosystem and its organisms.

We can study the effects of biotic and abiotic factors on organisms and populations in a schoolyard ecosystem.

We can analyze data to explore how the elk population changed in Yellowstone before and after the reintroduction of wolves.

Human Dependence on Natural Resources

Investigative Phenomena: Where are natural resources located on Earth?

Everyday Phenomena:

Human activity has an effect on the supply of nonrenewable natural resources.

Geological events, such as volcanic activity, affect the distribution of natural resources.

Natural resources are vulnerable to consequences, based on how the resource is used.

The human population affects the production and consumption of fossil fuels.

Structure of Matter

Investigative Phenomena: How can matter made of the same substances look so different?

Everyday Phenomena:

The names and symbols of the periodic table give us information about elements.

Molecules are made of atoms.

Solid crystals allow us to identify atoms, molecules, repeating subunits, and extended structures.

Elements are classified on the periodic table.

Changes in Energy on the Molecular Level

Investigative Phenomena: What happens to substances when we change the amount of available thermal energy?

Everyday Phenomena:

We can use a model to visualize cause-and-effect relationships between temperature, particle motion, and state of matter.

The temperature of a substance is related to its average kinetic energy.

Pressure affects particle motion in the different states of matter.

Heat and Matter

Investigative Phenomena: Does something that is hot have more thermal energy than something that is cold?

Everyday Phenomena:

We can model molecular kinetic energy.

Temperature, thermal energy, and conductivity have effects on the ability of a substance to heat or be heated.

PHENOMENA SEGMENT 2

Matter Cycles & Energy Flows through Organisms & Rocks

7th Grade

Mission Story: The "Mars Expedition Design Challenge" enables the winning design team to put the first group of humans on another planet. Students must create a plan that includes three design considerations: transportation, food, and shelter. They will present it to committee members for evaluation, then will have an opportunity to modify the plan before submitting the final proposal.

Anchoring Event: Humans can successfully colonize Mars if they are able to supply means to meet basic human needs: food, water, shelter, air to breathe, and protection from the harsh conditions on Mars.

The students view a video of beans germinating and participate in a teacher-led discussion about how seeds get everything they need to sprout from inside their closed system. The teacher guides the discussion to the relation to the law of conservation of mass, how organisms get the energy and other resources they need, and what resources humans would need to successfully colonize Mars.

Anchoring Phenomena Driving Question: How can humans successfully colonize Mars?

Characteristics of Chemical Reactions

Investigative Phenomena: What distinguishes a chemical reaction from a physical reaction?
Everyday Phenomena:
Atoms are rearranged to form new substances during chemical reactions.
We can recreate a chemical reaction and test various reactants to yield the same product.
Properties of a compound are different from the properties of the elements it is composed of.

Physical and Chemical Properties

Investigative Phenomena: How can we tell if a chemical reaction has occurred?
Everyday Phenomena:
We can collect and analyze data on the properties of various materials.
Chemical and physical properties can be used to identify matter regardless of quantity.
We can identify substances by comparing their physical and chemical properties.
We can create dot and bar charts to explore the densities of various materials.

Modeling Conservation of Mass

Investigative Phenomena: Can we create matter?
Everyday Phenomena:
Chemical reactions support the law of conservation of matter.
We can conduct an investigation to model the law of conservation of matter.
We can design an airbag prototype to model conservation of matter.

Thermal Energy in Chemical Reactions

Investigative Phenomena: Why do some chemical reactions result in something hot, while others result in something cold?
Everyday Phenomena:
We can observe the transfer of energy in chemical reactions and track energy flows as reactions absorb or release energy.
We can design a device, such as a portable heater, that uses a chemical reaction to release thermal energy to its surroundings.

Introduction to Photosynthesis

Investigative Phenomena: What food do plants eat for energy?
Everyday Phenomena:
We can model the various molecular-level components of photosynthesis.
Light is an important element of photosynthesis.

Energy Flow in Organisms

Investigative Phenomena: How does the food we eat give us energy?
Everyday Phenomena:
The food we eat gives us energy.
Matter is conserved during cellular respiration.
We can calculate the amount of energy in food.

Earth Materials

Investigative Phenomena: What processes cause the cycling of Earth's materials?
Everyday Phenomena:
We can develop and use a model to describe the rock cycle.
The rate of cooling crystals of phenyl salicylate affects the size of crystal formation.
Energy causes chemical and physical changes in Earth's materials and living organisms.

7th Grade

PHENOMENA SEGMENT 3

Natural Processes & Human Activities Shape Earth's Resources and Ecosystems

Mission Story: Scientists believe that the continents were a single super continent over 300 million years ago, and that these continents will form another super continent over the next 250 million years. The Mission Log shows where they believe the continents will collide. As newspaper reporters, students write a story informing the public about the effects the colliding continents will have on the matter and energy flow within the new ecosystems.

Anchoring Event: The movement of continents in the future could increase biodiversity and change the energy flow in new ecosystems.

The students view a video of inflatables in a pool, then participate in a teacher-led discussion about how the inflatables' motion illustrates how energy is transferred as they collide. The teacher then guides the discussion toward the movement of continents on the Earth's surface, and how that affects matter and energy flow within new ecosystems.

Anchoring Phenomena Driving Question: How will the movement of continents affect the matter and energy flow within the new ecosystems?

Relationships in Ecosystems

Investigative Phenomena: What different interactions can occur between organisms?

Everyday Phenomena:

Organisms can have predatory, competitive, or mutually beneficial interactions with one another.

Ecosystems have their own set of interactions between biotic and abiotic factors.

Organism interactions affect an ecosystem's population.

Flow of Energy in Ecosystems

Investigative Phenomena: What is matter used for?

Everyday Phenomena:

Food webs model the flow of matter and energy of multiple organisms in an ecosystem.

Matter and energy cycle through the living and nonliving parts of an ecosystem.

Plate Tectonics

Investigative Phenomena: How can the same species of fossil be found on different continents?

Everyday Phenomena:

Continents that may have once been joined have moved away from one another over time.

The distribution of fossils, rock formations, and continental shapes provides historical evidence of tectonic plate motion.

We can use evidence to support Wegener's theory of continental drift.

Seafloor Spreading

Investigative Phenomena: What does the seafloor look like?

Everyday Phenomena:

Seafloor spreading is formed from new magma production along divergent plate boundaries and the recycling of oceanic crust at subduction zones.

We can analyze data to show that the Eurasian and North American continental plates move in relation to one another.

PHENOMENA SEGMENT 4

Sustaining Biodiversity & Ecosystem Services in a Changing World

7th Grade

Mission Story: A team of student scientists will analyze geoscience processes and predict their effects on the biodiversity of organisms found around Sunnyville, California in 40 years. They will analyze a map of landforms and organisms living in the area and note any possible impacts on the current populations. They will then present findings, including a possible solution to mitigate the impact of these processes on the biodiversity of certain populations.

Anchoring Event: Geoscience processes in the future could lead to greater biodiversity and greater competition in an ecosystem.

The students view a video of an avalanche and then participate in a teacher-led discussion about the impact of natural hazards, predicting them, preparing for them, and the changes they cause in an ecosystem. The teacher guides the discussion to how geoscience processes can affect biodiversity in the future.

Anchoring Phenomena Driving Question: How will geoscience processes affect biodiversity in Sunnyville, California 40 years from now?

Dynamic Nature of Ecosystems

Investigative Phenomena: How can the increase in the population of an organism affect an entire ecosystem?

Everyday Phenomena:

Algae blooms and humans can both affect ecosystems.

Disruptive elements, such as a tornado, hurricane, or flooding, affect populations and communities in an ecosystem.

The squirrel population is affected by limited resources in an ecosystem.

Changes in ecosystems, such as annual temperature, affect animal populations.

Ecosystem Biodiversity

Investigative Phenomena: Why is biodiversity important in an ecosystem?

Everyday Phenomena:

Biodiversity makes an ecosystem more productive and sustainable.

Changing the biodiversity of ocean life affects the food chains.

We can design and model a wetland mitigation project.

The population of California condors has changed over time.

Geoscience Processes

Investigative Phenomena: How has Earth's surface changed over time?

Everyday Phenomena:

We can model the scale of geoscience processes.

Earth's surface has changed over time by processes that are large or small, fast or slow.

Landforms have changed over time due to meteorites, asteroids, and volcanic eruptions.

Weathering and Erosion

Investigative Phenomena: What processes shaped Earth's surface?

Everyday Phenomena:

Weather and erosion of landforms are the effects of flowing water, wind, and ice.

The slope of land affects weathering, erosion, and delta deposition.

Areas of Earth, often made of limestone, form caverns with formations such as stalactites and stalagmites.

There is a relationship between erosion (sediment load) and climate.

Natural Hazard Predictions

Investigative Phenomena: Which countries are most predisposed to natural disasters, and what extra precautions can they take ahead of time?

Everyday Phenomena:

Maps and data patterns can help forecast locations and likelihoods of future catastrophic events such as volcanic eruptions and earthquakes.

We can collect data, such as location, magnitude, and frequencies, of natural hazards.

We can use data and mitigation to minimize the impact of natural hazards.

Synthetic Materials

Investigative Phenomena: Is it better to use synthetic materials or natural resources?

Everyday Phenomena:

We can classify materials as natural, synthetic, renewable, and nonrenewable.

Natural resources can be used to create synthetic materials.

8th grade

PHENOMENA SEGMENT 1

Objects Move & Collide

Mission Story: Students are sports medicine doctors or orthopedists. Patients come to the office with a wide variety of sports-related injuries, and students diagram the forces that caused each injury. They then design a device to help each patient through the rehabilitation process and/or prevent the injury from happening again.

Anchoring Event: Unbalanced forces, such as collisions, quick stops, and gravity, can lead to sports injuries.

The students view a video of a dog skateboarding and then participate in a teacher-led discussion about how the dog uses forces to move the skateboard while working against gravity and friction. The teacher guides the discussion to how forces change the motion of objects, and how unbalanced forces cause sports injuries.

Anchoring Phenomena Driving Question: How do unbalanced forces cause sports injuries?

Newton's Third Law of Motion

Investigative Phenomena: What happens when two objects collide?

Everyday Phenomena:

We can measure force and newton as a unit of force.

We can observe Newton's third law of motion through the force of interacting objects.

We can design a prototype that will protect the environment when a driver collides with a stationary object.

Changes in Force and Motion

Investigative Phenomena: Why do some objects require more force to move than others?

Everyday Phenomena:

Unbalanced forces cause a change in motion, while balanced forces do not.

A change in an object's motion depends on the forces applied on the object and the mass of the object itself.

We can measure the relationship between a bike's weight and its jump weight.

Gravitational Forces

Investigative Phenomena: What causes the amount of gravitational force to change?

Everyday Phenomena:

Objects with greater mass have greater kinetic energy.

Objects with greater speed have greater kinetic energy.

We can use what we know about kinetic energy to design devices to keep us safer.

Kinetic Energy

Investigative Phenomena: What is the relationship of mass and speed to kinetic energy?

Everyday Phenomena:

Objects with greater mass have greater kinetic energy.

Objects with greater speed have greater kinetic energy.

We can use change in velocity to measure the effectiveness of a football helmet.

PHENOMENA SEGMENT 2

Noncontact Forces Influence Phenomena

8th grade

Mission Story: Students are part of a shuttle crew completing a one-year (365-day) journey in space to collect data. Their primary duty is to create a video log of significant discoveries made throughout the journey.

Anchoring Event: Gravitational and magnetic forces influence objects without touching them.

The students view a video of a person using a compass, then participate in a teacher-led discussion about the compass as a system affected by an unseen force, much like celestial bodies in the solar system. The teacher then guides the discussion to how an object can influence the motion of another object without touching it.

Anchoring Phenomena Driving Question: How can an object influence the motion of another object without touching it?

Potential Energy

Investigative Phenomena: What can change the amount of potential energy in an object?

Everyday Phenomena:

An object's distance from Earth can change its amount of potential energy.

The greater the static charge on a balloon, the greater the distance at which it can react to a piece of tissue paper.

An object has the most kinetic energy when it is traveling at its fastest speed and the most potential energy at its highest point when it is stopped.

We can design a prototype of a half pipe that will allow a marble to travel down one side, and up the other side, and land in a cup.

Earth, Sun, and Moon System

Investigative Phenomena: What patterns are caused by the Earth, Sun, and Moon system?

Everyday Phenomena:

Light from the Sun and the revolution of the Moon around the Earth cause the lunar cycle.

The Earth, Sun, and Moon cause seasons as a result of the amount of light received by Earth's hemispheres, due to the tilt of Earth on its axis and revolution around the Sun.

The Earth, Sun, and Moon cause eclipses when one astronomical body blocks light from or to another.

We can predict eclipses and the number of daylight hours.

Formation and Motion of Galaxies

Investigative Phenomena: How does gravity affect galaxies?

Everyday Phenomena:

All energy and matter that exist are found within the universe, yet according to the big bang theory, matter did not exist before the big bang occurred.

Gravity, combined with initial velocities of matter, create orbital pathways that objects travel in.

Gravity is the force that keeps the planets in the galaxy in orbit.

The Solar System

Investigative Phenomena: How big are the objects in the solar system?

Everyday Phenomena:

We can model relative distance between the planets.

Larger objects attract smaller objects; distance between objects makes a difference in the amount of attraction, thus the law of universal gravitation.

We can analyze and interpret data on various scale properties of planets.

Electric and Magnetic Forces

Investigative Phenomena: How can we increase the strength of an electric or magnetic force?

Everyday Phenomena:

We can create magnetic fields to simulate attractive and repulsive forces.

Like charged objects repel and opposite charged objects attract in interaction.

The strength of a magnetic field and exposure to an electric current has a cause-and-effect relationship.

8th grade

PHENOMENA SEGMENT 3

Evolution Explains Life's Unity & Diversity

Mission Story: Students create fictional organisms for an entertaining clay animation movie that educates the public on evolution. When describing the organisms' characteristics and evolution, students must use current knowledge of how species evolve and add unity and diversity to life through natural selection. They must show how an organism's age and environment can be predicted based on clues from rocks and fossils.

Anchoring Event: By studying rock strata and fossils, scientists have learned about the changes Earth's surface has undergone, and they have studied many structural similarities among different species of organisms.

The students view a video of an embryo developing. They participate in a teacher-led discussion about how the embryo provides clues to the type of species, just as fossils give us clues about prior environments. The teacher guides the discussion toward how the history of Earth and evidence of evolution give us clues about how Earth evolved and how species are similar and diverse.

Anchoring Phenomena Driving Question: How does the history of Earth and evidence of evolution give us clues about how Earth evolved and how species are similar and diverse?

Geologic History of Earth

Investigative Phenomena: How can we determine the approximate age of Earth?

Everyday Phenomena:

Geologists can use the law of superposition to learn when events occurred in Earth's past and the order in which they occurred.

A geological time scale can help you to understand the organization of phenomena over extremely large periods of time.

We can analyze rock strata and the fossil record within a model to determine the relative age of rock layers.

Fossil Record

Investigative Phenomena: How long does it take a bone to become a fossil?

Everyday Phenomena:

Five mass extinctions have occurred over time. Layers of rock and fossils can be studied to determine the nature of the environment at the time those organisms died.

Embryonic Similarities

Investigative Phenomena: Do embryos of different species develop the same?

Everyday Phenomena:

Patterns in data can reveal the embryonic developmental stages of animals.

Evolutionary History and Relationships

Investigative Phenomena: Are modern organisms different from organisms of the past?

Everyday Phenomena:

We can analyze anatomical similarities and differences among modern organisms to infer evolutionary relationships.

Patterns of skeletal structures representing ancestral lines of an animal can be used to identify the ancestral line of an organism.

Comparing life forms of today to fossils can give you information about evolutionary history and relationships.

PHENOMENA SEGMENT 3

Evolution Explains Life's Unity & Diversity

8th grade

Natural Selection

Investigative Phenomena: Why do some traits of the same species vary?

Everyday Phenomena:

Survival of the fittest is the existence of organisms that have the most favorable traits and are best adapted to their environment.

Bird beaks of finches vary in the Galapagos Islands, where birds with larger beaks are more likely to adapt and survive in their environment.

Changes in animals' environments in relation to genetic variations can affect the survival of animals with a weaker traits.

Physical or behavioral adaptations can provide survival advantages in animals.

Types of seeds caused the population of finches to change over time in the Galapagos Islands.

Genes and Proteins

Investigative Phenomena: What do proteins have to do with your traits?

Everyday Phenomena:

Chromosomes and genes are passed from parent to offspring.

Genes control the type of proteins produced and the type of protein determines the inherited traits.

Mutations

Investigative Phenomena: Are all mutations harmful?

Everyday Phenomena:

Mutations occur when a portion of an organism's DNA is replaced with a different part, part of the DNA is deleted, or a new piece of DNA inserts itself into the chain of existing DNA.

Mutations can be classified as beneficial, harmful, and/or neutral in a simple system.

Artificial Selection

Investigative Phenomena: How can humans pick traits of organisms?

Everyday Phenomena:

We can selectively breed dogs based on dogs' traits. In artificial selection, humans and new technologies have the capacity to influence certain characteristics of organisms by selective breeding.

8th grade

PHENOMENA SEGMENT 4

Sustaining Local & Global Biodiversity

Mission Story: Students are ecological researchers and want to study the bats and dolphins near a remote island. They do not want to disturb the natural order of the island, so they must design a device to detect the number of different species. Both types of animals use waves to communicate. Dolphins chirp to each other through analog waves, and bats use a type of digital wave called echolocation.

Anchoring Event: By listening to and identifying types of sounds organisms emit, scientists are able to determine the biodiversity in an ecosystem.

After viewing a video of students learning Morse code, the students participate in a teacher-led discussion about Morse code as a type of analog communication, with sound waves that travel through the air in patterns. These waves do not have a significant impact on the environment like other technology. The teacher guides the discussion to how interpreting waves can be used to measure biodiversity.

Anchoring Phenomena Driving Question: How can interpreting waves be used to measure biodiversity?

Human Impact on the Environment

Investigative Phenomena: How does our use of natural resources impact the environment?

Everyday Phenomena:

The human population has both positive and negative effects on air pollution.

Humans' use of carbon dioxide has negative effects on the ocean and its organisms.

We can design a system that monitors human effects on a natural habitat.

Introduction to Properties of Waves

Investigative Phenomena: What is the relationship between amplitude and energy of waves?

Everyday Phenomena:

Wave crest, wave length, wave height, wave trough, and amplitude are all parts of a wave.

Patterns and relationships (e.g., frequency and energy, amplitude and energy) exist in simple waves.

We can create a mechanical oscilloscope to create sound energy and also see the wave created by a rubber band that produces sound energy.

Modeling Waves through Various Mediums

Investigative Phenomena: How do sound waves interact with various materials?

Everyday Phenomena:

We can see sound waves through both water and enlarged ear drum representation.

We can model sound wave absorption, reflection, and transmission.

Geologists can detect how seismic waves travel through Earth's interior.

Sounds travel faster through denser mediums.

Properties of Visible Light

Investigative Phenomena: What are the properties of visible light?

Everyday Phenomena:

We can simulate the light path between transparent materials and the frequency of different colors of light.

Colored lights appear different when shining on different colored objects.

Visible light waves have different interactions with different materials, such as reflection, absorption, and transmission.

Certain materials, such as window treatments, can function to block outside light.

Light can change speed and direction when it passes through or strikes various mediums.

Modeling Light Waves

Investigative Phenomena: How do light waves interact with various materials?

Everyday Phenomena:

The angle of refraction is dependent on the color or frequency of a light ray and the medium through which it passes.

The brightness of a light is reduced as it transmits through a material.

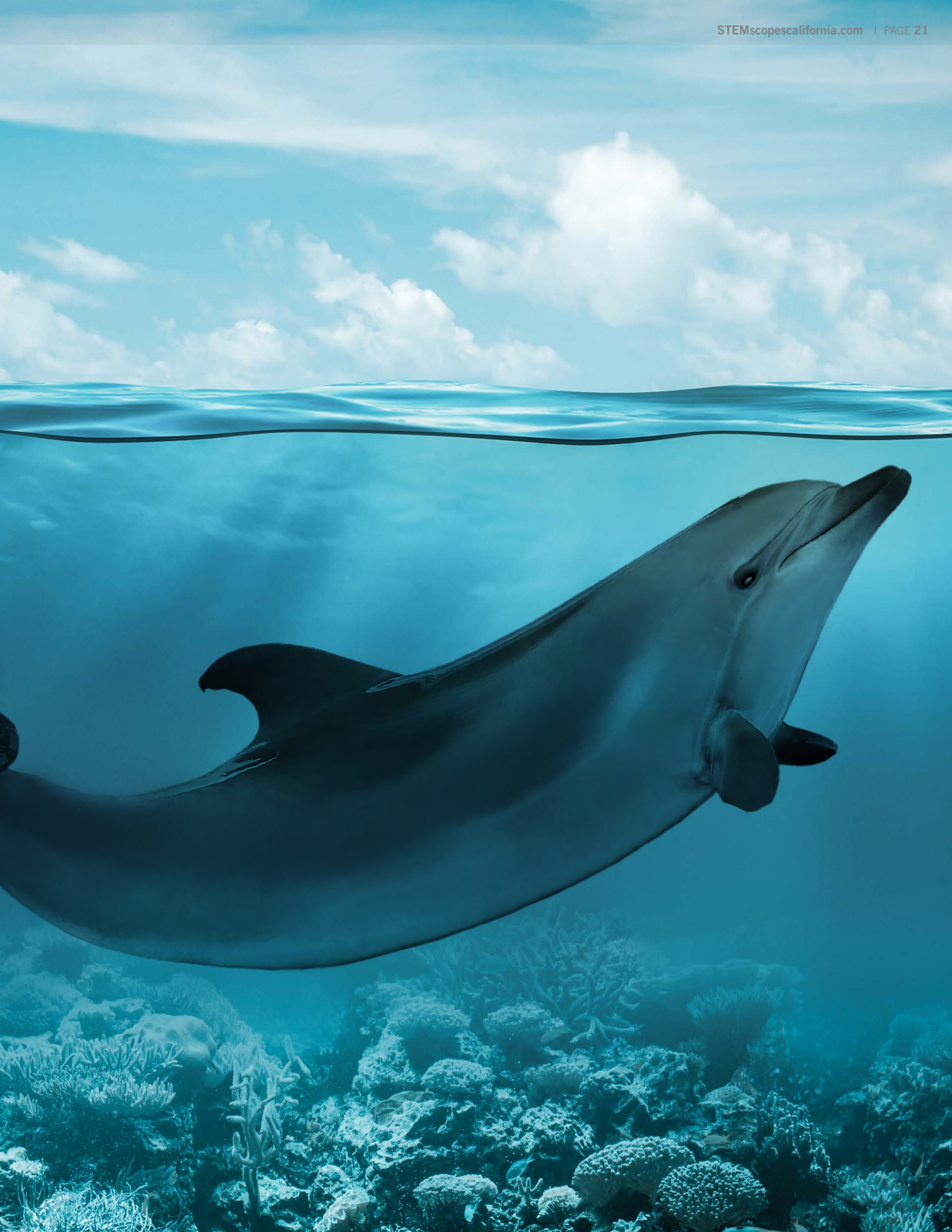
Digital vs. Analog Signals

Investigative Phenomena: What are the differences between digital and analog signals?

Everyday Phenomena:

We can create models of digital signals from binary code.

Using waves to carry digital signals is a more reliable way to encode and transmit information than using waves to carry analog signals.



life science

PHENOMENA SEGMENT 1

Structure, Function, & Information Processing

Mission Story: The students are mountain guides planning a family's week-long backpacking trip to the Grand Canyon. The family is from out of state and is not accustomed to the arid conditions of this region. Students will create a preparedness plan with supplies they will need before embarking on their journey.

Anchoring Event: Living things are adapted to their environment.

The students will first interact with a 360° image of Antarctica, then participate in a teacher-led discussion about how all living things are made of cells and systems. The teacher then guides the discussion toward how all organisms need sense receptors for survival, and ways on organism can survive in an unfamiliar environment.

Anchoring Phenomena Driving Question: How does an organism survive in an unfamiliar environment?

Cells

Investigative Phenomena: What is the smallest thing that can be considered living?
Everyday Phenomena:
An organism is either unicellular or multicellular.
All living things are made of cells.

Anatomy of a Cell

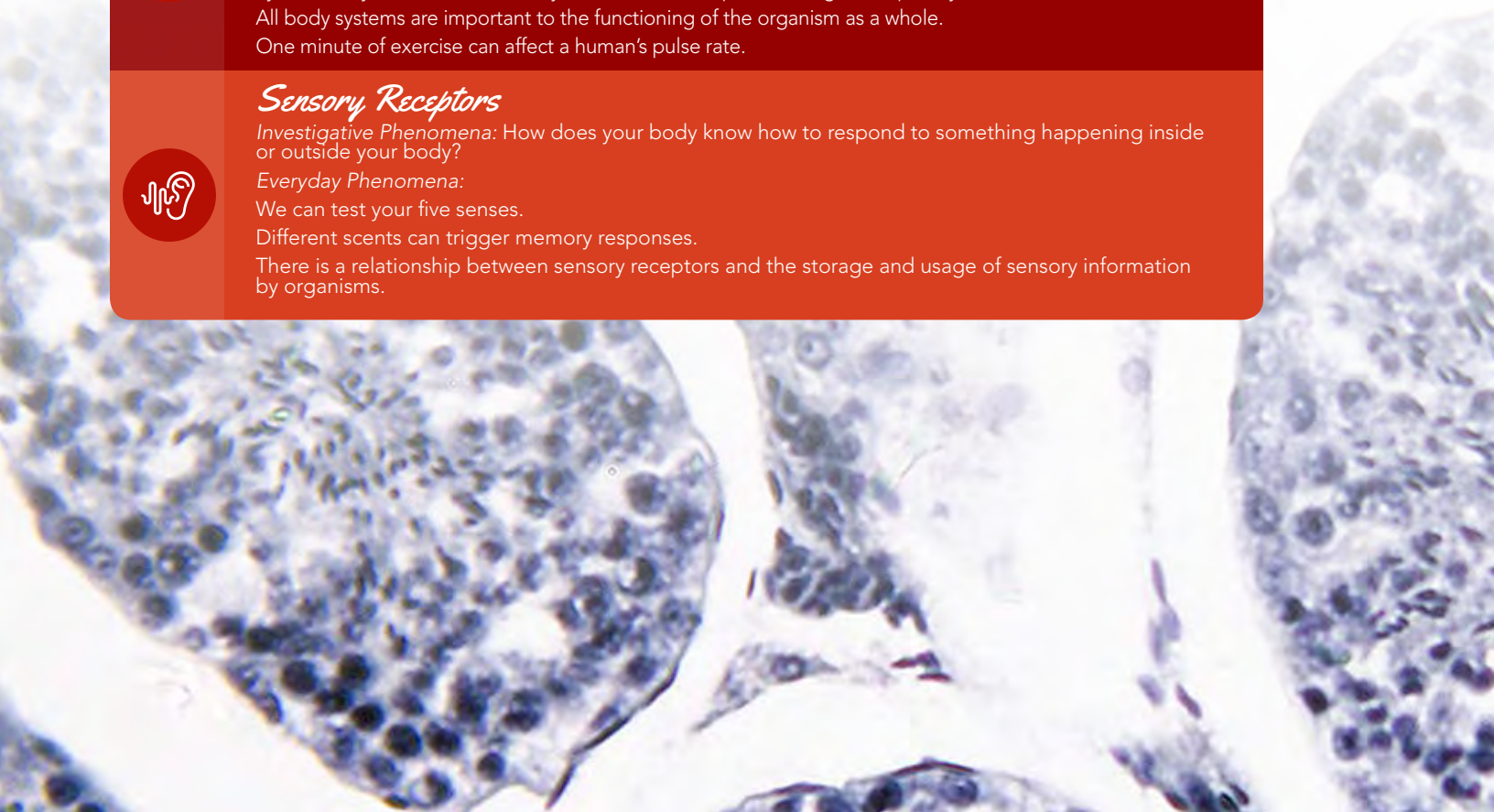
Investigative Phenomena: How can a single-celled organism sustain life?
Everyday Phenomena:
A plant cell is different from an animal cell.
Different parts of a cell contribute to how a cell functions and stays healthy.

Bodies and Systems

Investigative Phenomena: Why can you not function properly without one of your body systems?
Everyday Phenomena:
Human subsystems interact to carry out the functions of the human body.
Systems may interact with other systems and can be part of a larger complex system.
All body systems are important to the functioning of the organism as a whole.
One minute of exercise can affect a human's pulse rate.

Sensory Receptors

Investigative Phenomena: How does your body know how to respond to something happening inside or outside your body?
Everyday Phenomena:
We can test your five senses.
Different scents can trigger memory responses.
There is a relationship between sensory receptors and the storage and usage of sensory information by organisms.



PHENOMENA SEGMENT 2

Growth & Development of Organisms

life science

Mission Story: Students are landscape designers hired by a large company that wants to become more environmentally friendly. Students will design a visually pleasing garden and composting area that will attract and promote organism interactions.

Anchoring Event: Through composting and gardening, humans can support growth and development of plants and animals.

The students view a video of strawberries decomposing after undergoing photosynthesis. They participate in a teacher-led discussion about how plants attract organisms to garden locations and promote energy flow through ecosystems. The teacher then guides the discussion toward how we can promote growth and development of plants and animals.

Anchoring Phenomena Driving Question: How can we promote the growth and development of plants and animals?

Reproduction in Plants and Animals

Investigative Phenomena: What characteristics do plants and animals have that increase their chances of reproduction?

Everyday Phenomena:

The spawning behaviors of fish affect their reproduction success.

Plants and animals develop various adaptations to help their species survive.

Certain parts of a flower attract pollinators better than other parts.

Growth of Organisms

Investigative Phenomena: Do environmental or genetic factors affect the growth of organisms most?

Everyday Phenomena:

Environmental and genetic factors affect a plant's survival.

Environmental factors and genetic traits affect the growth of organisms.

Introduction to Photosynthesis

Investigative Phenomena: What food do plants eat for energy?

Everyday Phenomena:

We can model the various molecular-level components of photosynthesis.

Light is an important element of photosynthesis.

Energy Flow in Organisms

Investigative Phenomena: How does the food we eat give us energy?

Everyday Phenomena:

The food we eat gives us energy.

Matter is conserved during cellular respiration.

We can calculate the amount of energy in food.

life science

PHENOMENA SEGMENT 3

Interdependent Relationships in Ecosystems

Mission Story: The students are environmental engineers hired to survey a region in order to determine the effects of running an oil pipeline through the local ecosystems, including Yosemite National Park and the Tuolumne River. Students will create a report that maps out the benefits and risks of the pipeline, the effects on food webs in Yosemite National Park, and the park's biodiversity.

Anchoring Event: Changes to ecosystems can result in both positive and negative impacts to the organisms living there.

The students view a video of a hotel in a forest, and participate in a teacher-led discussion about the impact of the hotel on available resources and biodiversity in the forest. The teacher then guides the discussion toward how changes in ecosystems affect interactions and relationships among organisms.

Anchoring Phenomena Driving Question: How can changes in ecosystems affect interacting relationships among organisms in an area?

Competition in Ecosystems

Investigative Phenomena: How does the amount of resources in an ecosystem affect populations?

Everyday Phenomena:

Biotic and abiotic factors can drive the relationships between organisms and what combinations of organisms exist in an ecosystem.

Interacting populations rely on limited resources within an ecosystem.

Organism Interactions in Ecosystems

Investigative Phenomena: How can a change to the population of one species affect an entire ecosystem?

Everyday Phenomena:

Changes within the components of an ecosystem have an effect on the ecosystem and its organisms.

We can study the effects of biotic and abiotic factors on organisms and populations in a schoolyard ecosystem.

We can analyze data to explore how the elk population changed in Yellowstone before and after the reintroduction of wolves.

Relationships in Ecosystems

Investigative Phenomena: What different interactions can occur between organisms?

Everyday Phenomena:

Organisms can have predatory, competitive, or mutually beneficial interactions with one another.

Ecosystems have their own set of interactions between biotic and abiotic factors.

Organism interactions affect an ecosystem's population.

Flow of Energy in Ecosystems

Investigative Phenomena: What is matter used for?

Everyday Phenomena:

Food webs model the flow of matter and energy of multiple organisms in an ecosystem.

Matter and energy cycle through the living and nonliving parts of an ecosystem.

Dynamic Nature of Ecosystems

Investigative Phenomena: How can the increase in the population of an organism affect an entire ecosystem?

Everyday Phenomena:

Algae blooms and humans can both affect ecosystems.

Disruptive elements, such as a tornado, hurricane, or flooding, affect populations and communities in an ecosystem.

The squirrel population is affected by limited resources in an ecosystem.

Changes in ecosystems, such as annual temperature, affect animal populations.

Ecosystem Biodiversity

Investigative Phenomena: Why is biodiversity important in an ecosystem?

Everyday Phenomena:

Biodiversity makes an ecosystem more productive and sustainable.

Changing the biodiversity of ocean life affects the food chains.

We can design and model a wetland mitigation project.

The population of California condors has changed over time.

PHENOMENA SEGMENT 4

Inheritance & Variation of Traits

life science

Mission Story: The students are veterinary lab technicians. As part of their job duties, students help analyze blood samples of their animal patients. This past week, students have analyzed blood samples from two rabbits with similar symptoms. The head veterinarian needs help to determine if these rabbits have a genetic disorder or simply a virus.

Anchoring Event: Genetic disorders occur when harmful mutations are passed from parents to offspring.

The students view a video of an albino deer, then participate in a teacher-led discussion about how the deer has an inherited mutation that may affect its ability to survive and reproduce. The teacher then guides the discussion toward how inherited traits, including harmful mutations, can be passed on to future offspring.

Anchoring Phenomena Driving Question: Can harmful mutations be passed on to future offspring?

Genes and Proteins

Investigative Phenomena: What do proteins have to do with your traits?

Everyday Phenomena:

Chromosomes and genes are passed from parent to offspring.

Genes control the type of proteins produced and the type of protein determines the inherited traits.

Mutations

Investigative Phenomena: Are all mutations harmful?

Everyday Phenomena:

Mutations occur when a portion of an organism's DNA is replaced with a different part, part of the DNA is deleted, or a new piece of DNA inserts itself into the chain of existing DNA.

Mutations can be classified as beneficial, harmful, and/or neutral in a simple system.

Inheritance and Genetic Variation

Investigative Phenomena: How can siblings look so different if they share the same parents?

Everyday Phenomena:

Siblings do not look identical to each other due to a variety of inherited and mixed traits.

Dominant and recessive alleles affect traits.

We can predict possible genetic outcomes.

We can design prototypes of predicted offspring from asexual reproduction.

life science

PHENOMENA SEGMENT 5

Evidence of Common Ancestry & Diversity

Mission Story: Students are curators at the Natural Science Museum. Recently, a museum visitor challenged the legitimacy of the museum's fossil exhibit. News reporters have started calling to ask if the museum has falsified any of its artifacts. Students write a press release defending the exhibits, accuracy, providing evidence from the fossil record, evolutionary relationships, and embryonic similarities.

Anchoring Event: Fossils tell us that organisms existed millions of years ago and give us clues about their appearance and where and how they lived.

The students view a video of an embryo developing. They participate in a teacher-led discussion about how the embryo provides clues to the type of species, just as fossils give us clues about prior environments. The teacher guides the discussion toward how we know organisms existed millions of years ago.

Anchoring Phenomena Driving Question: How do we know that organisms existed millions of years ago?

Fossil Record

Investigative Phenomena: What mass extinctions have occurred over time?

Everyday Phenomena:

Five mass extinctions have occurred over time.

Layers of rock and fossils can be studied to determine the nature of the environment at the time those organisms died.

Evolutionary History and Relationships

Investigative Phenomena: Are modern organisms different from organisms of the past?

Everyday Phenomena:

We can analyze anatomical similarities and differences among modern organisms to infer evolutionary relationships.

Patterns of skeletal structures representing ancestral lines of an animal can be used to identify the ancestral line of an organism.

Comparing life forms of today to fossils can give you information about evolutionary history and relationships.

Embryonic Similarities

Investigative Phenomena: What can you find out by comparing embryos of different species?

Everyday Phenomena:

Patterns in data can reveal the embryonic developmental stages of animals.

PHENOMENA SEGMENT 6

Changes in Organisms over Time

life science

Mission Story: Students are corn farmers whose crops have just suffered serious damage from a tornado. It is halfway through the growing season and the farmers are worried about the decreased income from the smaller harvest. They decide to crossbreed corn with another plant to create a new corn breed that grows fast enough to get crops to a full harvest. However, first they must write a proposal to the FDA justifying the need for this new crop and seeking FDA approval.

Anchoring Event: Humans breed plants and animals to develop particular traits they want to develop.

The students first view a video of paint colors being mixed, then participate in a teacher-led discussion about how mixing colors gives us new colors. The teacher then guides the discussion toward inherited traits, especially ones that help the organism survive, and how organisms can be bred for specific purposes.

Anchoring Phenomena Driving Question: How can organisms be bred for specific purposes?

Natural Selection

Investigative Phenomena: Why do some traits of the same species vary?

Everyday Phenomena:

Survival of the fittest is the existence of organisms that have the most favorable traits and are best adapted to their environment.

Bird beaks of finches vary in the Galapagos Islands, where birds with larger beaks are more likely to adapt and survive in their environment.

Changes in animals' environments in relation to genetic variations can affect the survival of a animals with weaker traits.

Physical or behavioral adaptations can provide animals survival advantages.

Types of seeds available for food caused the population of finches to change over time in the Galapagos Islands.

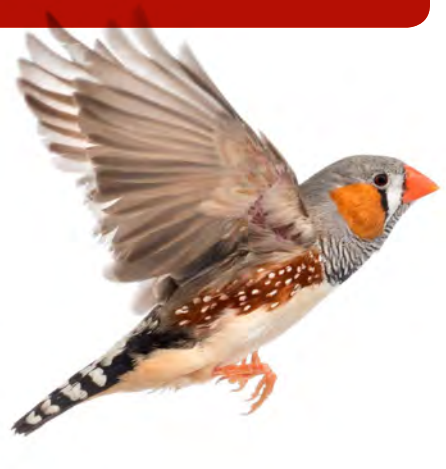
Artificial Selection

Investigative Phenomena: How can humans pick traits of organisms?

Everyday Phenomena:

We can selectively breed dogs based on dogs' traits.

In artificial selection, humans and new technologies have the capacity to influence certain characteristics of organisms by selection breeding.



physical

PHENOMENA SEGMENT 1

Chemical Reactions

Mission Story: Students will create their own chemical reactions using fictional substances. Their substances should include a chemical equation and a description of the atomic structure of the substances used, the properties of the reactants and products, and how matter is conserved during the reaction.

Anchoring Event: During a chemical reaction, the overall mass of the substances before and after the reaction stays the same.

The students view a video of beans germinating and participate in a teacher-led discussion about how seeds get everything they need to sprout from inside their closed system, thus conserving mass. The teacher then guides the discussion to photosynthesis as a chemical reaction, and how chemical reactions can be used to describe the law of conservation of mass.

Anchoring Phenomena Driving Question: How can chemical reactions be used to describe the law of conservation of mass?

Structure of Matter

Investigative Phenomena: How can matter made of the same substances look so different?
Everyday Phenomena:
The names and symbols of the periodic table give us information about elements.
Molecules are made of atoms.
Solid crystals allow us to identify atoms, molecules, repeating subunits, and extended structures.
Elements are classified on the periodic table.

Physical and Chemical Properties

Investigative Phenomena: How can we tell if a chemical reaction has occurred?
Everyday Phenomena:
We can observe density as a physical property of matter.
Chemical and physical properties can be used to identify matter, regardless of quantity.
We can identify substances by comparing their physical and chemical properties.
We can create dot and bar charts to explore the densities of various materials.

Synthetic Materials

Investigative Phenomena: Is it better to use synthetic materials or natural resources?
Everyday Phenomena:
We can classify materials as natural, synthetic, renewable, and nonrenewable.
Natural resources can be used to create synthetic materials.

Characteristics of Chemical Reactions

Investigative Phenomena: What distinguishes a chemical reaction from a physical reaction?
Everyday Phenomena:
Atoms are rearranged to form new substances during chemical reactions.
We can recreate a chemical reaction and test various reactants to yield the same product.
Properties of a compound are different from the properties of the elements it is composed of.

Modeling Conservation of Mass

Investigative Phenomena: Can we create matter?
Everyday Phenomena:
Chemical reactions support the law of conservation of matter.
We can conduct an investigation to model the law of conservation of matter.
We can design an airbag prototype to model conservation of matter.

PHENOMENA SEGMENT 2

Structure & Properties of Matter

physical

Mission Story: The first mission to colonize the planet Mars has been scheduled. As NASA food engineers, students are tasked to create a model of a device that can be used to heat food. To minimize supplies carried on the mission, this device must use resources that are already found on Mars. Students will create a model of this device and write a summary of how it works.

Anchoring Event: Thermal energy transfers from hot matter to cold matter through conduction, convection, or radiation. Some states of matter get hotter more quickly than others.

The students view a video of glass bottles cooling and participate in a teacher-led discussion about how the bottles changed and the transfer of kinetic energy that occurred in that process. The teacher guides the discussion to how the transfer of thermal energy affects different types of matter.

Anchoring Phenomena Driving Question: How does the transfer of thermal energy affect different types of matter?

Heat and Matter

Investigative Phenomena: Does something that is hot have more thermal energy than something that is cold?

Everyday Phenomena:

We can model molecular kinetic energy.

Temperature, thermal energy, and conductivity have effects on the ability of a substance to heat or be heated.

Changes in Energy on the Molecular Level

Investigative Phenomena: What happens to substances when we change the amount of available thermal energy?

Everyday Phenomena:

We can use a model to visualize cause-and-effect relationships between temperature, particle motion, and state of matter.

The temperature of a substance is related to its average kinetic energy.

Pressure affects particle motion in the different states of matter.

Thermal Energy in Chemical Reactions

Investigative Phenomena: Why do some chemical reactions result in something hot, while others result in something cold?

Everyday Phenomena:

We can observe the transfer of energy in chemical reactions and track energy flows as reactions absorb or release energy.

We can design a device, such as a portable heater, that uses a chemical reaction to release thermal energy to its surroundings.

physical | PHENOMENA SEGMENT 3
Forces & Motion

Mission Story: Students are game designers for the A-MAZE-ing Corporation. Their job is to design an exciting tabletop maze game that challenges players to navigate the maze in the shortest amount of time. The company requires them to incorporate electricity, magnets, and gravitational forces into the design. Students design the game and provide a detailed analysis of the forces incorporated into the game.

Anchoring Event: Forces make objects move, stop, change direction, speed up, or slow down.

The students view a video of a dog skateboarding and then participate in a teacher-led discussion about how the dog uses forces to move the skateboard while working against gravity and friction. The teacher guides the discussion to the ways that forces affect motion in our daily lives.

Anchoring Phenomena Driving Question: How do forces impact motion in our daily lives?

Newton's Third Law of Motion
Investigative Phenomena: What happens when two objects collide?
Everyday Phenomena:
We can measure force and newton as a unit of force.
We can observe Newton's third law of motion through the force of interacting objects.
We can design a prototype that will protect the environment when a driver collides with a stationary object.

Changes in Force and Motion
Investigative Phenomena: Why do some objects require more force to move than others?
Everyday Phenomena:
Unbalanced forces cause a change in motion, while balanced forces do not.
We can measure the relationship between a bike's weight and its jump weight.

Electric and Magnetic Forces
Investigative Phenomena: How can we increase the strength of an electric or magnetic force?
Everyday Phenomena:
We can create magnetic fields to simulate attractive and repulsive forces.
Like charged objects repel and opposite charged objects attract in interaction.
The strength of a magnetic field and exposure to an electric current has a cause-and-effect relationship.

Gravitational Forces
Investigative Phenomena: What causes the amount of gravitational force to change?
Everyday Phenomena:
Objects with greater mass have greater kinetic energy.
Objects with greater speed have greater kinetic energy.
We can use what we know about kinetic energy to design devices to keep us safer.

PHENOMENA SEGMENT 4

Potential & Kinetic Energy

physical

Mission Story: Students are architectural engineers hired by the Olympic Committee to modify the long distance ski jump so it can be used in the summer. Students cannot use ice, and their design should result in the greatest jump distance possible. Students will create a labeled diagram of the ski jump that includes the material used and calculations of potential and kinetic energy.

Anchoring Event: Kinetic and potential energy work together in a system; as potential energy increases, kinetic energy decreases. As potential energy decreases, kinetic energy increases.

The students view a video of Newton's cradle, then participate in a teacher-led discussion about how kinetic and potential energy are being transformed back and forth on the device. The teacher guides the discussion to different ways that kinetic and potential energy interact in a system.

Anchoring Phenomena Driving Question: How do kinetic and potential energy interact in a system?

Kinetic Energy

Investigative Phenomena: What is the relationship of mass and speed to kinetic energy?

Everyday Phenomena:

Objects with greater mass have greater kinetic energy.

Objects with greater speed have greater kinetic energy.

We can use what we know about kinetic energy to design devices to keep us safer.

Potential Energy

Investigative Phenomena: What can change the amount of potential energy in an object?

Everyday Phenomena:

An object's distance from Earth can change its amount of potential energy.

The greater the static charge on a balloon, the greater the distance at which it can react to a piece of tissue paper.

An object has the most kinetic energy when it is traveling at its fastest speed and the most potential energy at its highest point when it is stopped.

We can design a prototype of a half pipe that will allow a marble to travel down one side, and up the other side, and land in a cup.

physical

PHENOMENA SEGMENT 5

Energy Transfer in Temperature

Mission Story: As engineers at an outdoor product development company, students are asked to design a device that will heat food to a certain temperature and maintain the food's temperature for an extended period of time after removal from the heat. They will draw and label the design, include a summary of how the device works, and present to the company's board.

Anchoring Event: Good conductors maximize thermal energy transfer in a system.

After viewing a video of a candle melting experiment, the students participate in a teacher-led discussion about how heat is transferred through metal more quickly than glass, generalizing to talk about conduction through different materials. The teacher guides the discussion to how the thermal energy transfer in a system can be maximized.

Anchoring Phenomena Driving Question: How can you maximize the thermal energy transfer in a system?

Thermal Energy Transfer

Investigative Phenomena: What types of material keep substances warm and cold?

Everyday Phenomena:

Thermal energy moves due to conduction, convection, and radiation.

Different types of matter affect thermal energy transfer in a designed system.

We can apply scientific ideas, such as volume of matter, to design, construct, and test a device that keeps medicine cold.

Temperature is a measure of the average kinetic energy of particles of matter.

Energy Transfer and Temperature

Investigative Phenomena: How does the matter and mass of a substance affect the transfer of energy?

Everyday Phenomena:

Different liquids change temperatures at different rates after ice has been added to them.

The amount of matter affects the rate at which the matter changes temperature when exposed to heat.

The transfer of energy is affected when there is a change in the environment.

The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.

PHENOMENA SEGMENT 6

Waves & Their Applications in Technologies & Information Transfer

physical

Mission Story: Students are pitching a new product on the popular show, Making Life Easier. They will design a device that uses light waves instead of digital signals to communicate. The sales pitch includes a visual and an explanation of how the device works, how it would make life easier, and the advantages of using light waves over digital signals.

Anchoring Event: Radio waves are used to transmit radio and television programs, and microwaves are used to transmit satellite television and for mobile phones.

After viewing a video of students learning Morse code, the students participate in a teacher-led discussion about Morse code as a type of analog communication, with sound waves that travel through the air in patterns. The teacher guides the discussion to the different types of waves used in technology and communication.

Anchoring Phenomena Driving Question: How are different types of waves used in technology and communication applications?

Introduction to Properties of Waves

Investigative Phenomena: What is the relationship between amplitude and energy of waves?

Everyday Phenomena:

Wave crest, wave length, wave height, wave trough, and amplitude are all parts of a wave.

Patterns and relationships (e.g., frequency and energy, amplitude and energy) exist in simple waves.

We can create a mechanical oscilloscope to create sound energy and also see the wave created by a rubber band that produces sound energy.

Modeling Waves through Various Mediums

Investigative Phenomena: How do sound waves interact with various materials?

Everyday Phenomena:

We can see sound waves through both water and enlarged ear drum representation.

We can model sound wave absorption, reflection, and transmission.

Geologists can detect how seismic waves travel through Earth's interior.

Sounds travel faster through denser mediums.

Properties of Visible Light

Investigative Phenomena: What are the properties of visible light?

Everyday Phenomena:

We can simulate the light path between transparent materials and the frequency of different colors of light.

Colored lights appear differently when shining on different colored objects.

Visible light waves have different interactions with different materials, such as reflection, absorption, and transmission.

Certain materials, such as window treatments, can function to block outside light.

Light can change speed and direction when it passes through or strikes various mediums.

Modeling Light Waves

Investigative Phenomena: How do light waves interact with various materials?

Everyday Phenomena:

The angle of refraction is dependent on the color or frequency of a light ray and the medium through which it passes.

The brightness of a light is reduced as it transmits through a material.

Digital vs. Analog Signals

Investigative Phenomena: What are the differences between digital and analog signals?

Everyday Phenomena:

We can create models of digital signals from binary code.

Using waves to carry digital signals is a more reliable way to encode and transmit information than using waves to carry analog signals.

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PHENOMENA SEGMENT 1

The Earth & the Solar System

Mission Story: Students are tour guides who will take a group of space travelers around the universe. Since this is their first visit, students will need to provide them with an informational map that shows all the objects they will visit, where they are located, and brief descriptions of the objects.

Anchoring Event: Our solar system is part of the vast universe, composed of stars, planets, moons, and other space objects that move in relation to one another, largely due to the pull of gravity.

The students will view a video of a car engine running and participate in a teacher-led discussion about how the engine's parts act as a system. The teacher guides the discussion toward the solar system, and how space objects move in relation to one another.

Anchoring Phenomena Driving Question: What space objects can be seen in the universe and how do they move in relation to each other?

Earth, Sun, and Moon System

Investigative Phenomena: What patterns are caused by the Earth, Sun, and Moon system?

Everyday Phenomena:

Light from the Sun and the revolution of the Moon around the Earth cause the lunar cycle.

The Earth, Sun, and Moon cause seasons as a result of the amount of light received by Earth's hemispheres, due to the tilt of Earth on its axis and revolution around the Sun.

The Earth, Sun, and Moon cause eclipses when one astronomical body blocks light from or to another.

We can predict eclipses and the number of daylight hours.

Formation and Motion of Galaxies

Investigative Phenomena: How does gravity affect galaxies?

Everyday Phenomena:

All energy and matter that exist are found within the universe, yet according to the big bang theory, matter did not exist before the big bang occurred.

Gravity, combined with initial velocities of matter, create orbital pathways that objects travel in.

Gravity is the force that keeps the planets in the galaxy in orbit.

The Solar System

Investigative Phenomena: How big are the objects in the solar system?

Everyday Phenomena:

We can model relative distance between the planets.

Larger objects attract smaller objects and distance between objects makes a difference in the amount of attraction, thus the law of universal gravitation.

We can analyze and interpret data on various scale properties of planets.

PHENOMENA SEGMENT 2

The History of Planet Earth

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Mission Story: Students work for NASA as planetary geologists and have just discovered a new planet in the "Goldilocks" zone of a different solar system. Students will create a model predicting the tectonic activity of the new planet to present to their fellow scientists at NASA.

Anchoring Event: The surface of Earth is constantly changing and will continue to change over time.

The students view a video of inflatables in a pool, then participate in a teacher-led discussion about how the inflatables' motion is like plate tectonics. The teacher then guides the discussion toward patterns in the movement of Earth's surface, and what clues can tell us about a planet's past and help us predict its future.

Anchoring Phenomena Driving Question: What clues can tell us about a planet's past and help us predict its future?

Geologic History of Earth

Investigative Phenomena: How can we determine the approximate age of Earth?

Everyday Phenomena:

Geologists can use the law of superposition to learn when events occurred in Earth's past and the order in which they occurred.

A geological time scale can help you to understand the organization of phenomena over extremely large periods of time.

We can analyze rock strata and the fossil record within a model to determine the relative age of rock layers.

Plate Tectonics

Investigative Phenomena: How can the same species of fossil be found on different continents?

Everyday Phenomena:

Continents that may have once been joined have moved away from one another over time.

The distribution of fossils, rock formations, and continental shapes provides historical evidence of tectonic plate motion.

We can use evidence to support Wegener's theory of continental drift.

Seafloor Spreading

Investigative Phenomena: What does the seafloor look like?

Everyday Phenomena:

Seafloor spreading is formed from new magma production along divergent plate boundaries and the recycling of oceanic crust at subduction zones.

We can analyze data to show that the Eurasian and North American continental plates move in relation to one another.

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PHENOMENA SEGMENT 3

Earth's Materials, Systems, & Natural Hazards

Mission Story: Students work for the United States Geological Survey (USGS) and have been tasked with creating an emergency response plan for a community near an active volcano. Their plan will include a before, during, and after volcano preparedness plan based on knowledge of Earth's materials, systems, and natural hazards.

Anchoring Event: By studying geoscience processes, we can predict and prepare for what may happen, including a natural disaster.

The students view a video of an avalanche and then participate in a teacher-led discussion about the impact of natural hazards, predicting them, preparing for them, and the changes they cause in an ecosystem. The teacher guides the discussion to how past geoscience processes tell us about Earth's materials and natural hazards.

Anchoring Phenomena Driving Question: What can past geoscience processes tell us about Earth's materials and natural hazards?

Earth Materials

Investigative Phenomena: What processes cause the cycling of Earth's materials?

Everyday Phenomena:

We can develop and use a model to describe the rock cycle.

The rate of cooling crystals of phenyl salicylate affects the size of crystal formation.

Energy causes chemical and physical changes in Earth's materials and living organisms.

Weathering and Erosion

Investigative Phenomena: What processes shaped Earth's surface?

Everyday Phenomena:

Weather and erosion of landforms are the effects of flowing water, wind, and ice.

The slope of land affects weathering, erosion, and delta deposition.

Areas of Earth, often made of limestone, form caverns with formations such as stalactites and stalagmites.

There is a relationship between erosion (sediment load) and climate.

Geoscience Processes

Investigative Phenomena: How has Earth's surface changed over time?

Everyday Phenomena:

We can model the scale of geoscience processes.

Earth's surface has changed over time by processes that are large or small, fast or slow.

Landforms have changed over time due to meteorites, asteroids, and volcanic eruptions.

Natural Hazard Predictions

Investigative Phenomena: Which countries are most predisposed to natural disasters, and what extra precautions can they take ahead of time?

Everyday Phenomena:

Maps and data patterns can help forecast locations and likelihoods of future catastrophic events such as volcanic eruptions and earthquakes.

We can collect data, such as location, magnitude, and frequencies, of natural hazards.

We can use data and mitigation to minimize the impact of natural hazards.

PHENOMENA SEGMENT 4

The Role of Water in the Earth's Surface, & Weather & Climate

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Mission Story: Students are consulting meteorologists working for an oil company in the Gulf of Mexico. They are asked to write a weather report that describes the development of a tropical depression off the coast of Africa into a hurricane over five days. This report includes the characteristics of each stage of hurricane development and the precautions the company needs to take so they know when to evacuate their oil rigs.

Anchoring Event: Hurricanes form as warm, moist air over warm ocean water rises and is replaced by cooler air. This cycle can repeat itself, causing huge storm clouds to form.

The students view a video of wind currents around the world, then participate in a teacher-led discussion about how wind currents affect water and transfer energy like hurricanes. The teacher then guides the discussion to how the patterns of interactions of air, ocean, and land can be used to predict the formation and movement of a hurricane.

Anchoring Phenomena Driving Question: How can the interactions of the air, ocean, and land be used to predict the formation and movement of a hurricane?

The Water Cycle

Investigative Phenomena: How does water cycle through Earth's systems?

Everyday Phenomena:

Water cycles through Earth's systems through processes of evaporation, condensation, precipitation, accumulation, percolation, and runoff.

Water cycles through Earth's systems driven by energy from the Sun and the force of gravity.

Predicting Weather

Investigative Phenomena: What causes changes in weather conditions?

Everyday Phenomena:

Motions and complex interactions of air masses result in changing weather conditions.

We can use computer-generated weather models and statistical data to answer scientific questions, such as the probability that a hurricane will make landfall at a specific location.

We can model air pressure, condensation, and heat transfer to predict phenomena using cause-and-effect relationships.

Landforms have an effect on weather and can cause rain shadows.

We can use maps to collect data and identify weather patterns.

Ocean Currents

Investigative Phenomena: How does the ocean influence weather and climate?

Everyday Phenomena:

Ocean currents are influenced by surface winds, temperature, salinity, the Earth's rotation, and ocean tides.

Ocean currents, warm currents, and cold currents affect weather and climate patterns.

Influences on Weather and Climate

Investigative Phenomena: What causes locations on Earth to have different climates?

Everyday Phenomena:

Unequal heating and rotation of Earth cause patterns of atmospheric circulation that determine regional climates such as those of equatorial and polar areas.

Wind and land masses affect ocean surface currents.

Ocean currents influence the climate of landmasses.

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PHENOMENA SEGMENT 5

Natural Resources & Human Impacts on Earth Systems

Mission Story: Students are environmental scientists hired by a film company to help produce a documentary about the effects of plastics on the environment. They will write a summary of the effects on the environment of removing petroleum from Earth and disposing of plastics. They will create a storyboard for the filmmakers to use while making their documentary.

Anchoring Event: There are positive and negative environmental impacts from the use of natural resources like petroleum.

The students view a video of a swan swimming in an oil spill. They participate in a teacher-led discussion about how oil spills caused by humans affect the organisms that live in the area and how fossil fuels contribute to climate change. The teacher guides the discussion to the impact of using natural resources on the environment.

Anchoring Phenomena Driving Question: How does the use of natural resources like petroleum affect the environment?

Human Impact on the Environment

Investigative Phenomena: How does our use of natural resources affect the environment?

Everyday Phenomena:

The human population affects air pollution.

Adding carbon dioxide to the ocean alters the ocean's habitat and affects its organisms.

We can design a system to monitor human effects on a natural habitat.

Human Activities and Global Climate Change

Investigative Phenomena: What factors have caused the rise in global temperatures over the past century?

Everyday Phenomena:

We can model the greenhouse effect and impacts of global warming on our oceans.

Human activity contributes to the causes of global warming.

Human Dependence on Natural Resources

Investigative Phenomena: Where are natural resources located on Earth?

Everyday Phenomena:

Human activity has an effect on the supply of nonrenewable natural resources.

Geological events, such as volcanic activity, affect the distribution of natural resources.

Natural resources are vulnerable to consequences, based on how the resource is used.

The human population affects the production and consumption of fossil fuels.

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