

Senior 2, Cluster 1: Dynamics of Ecosystems

Overview

In this cluster, students examine the complex relationships present in ecosystems in order to further investigate issues of sustainability. The large scale cycling of elements in biogeochemical cycles and the bioaccumulation of toxins in food chains are studied. Population dynamics are examined in the context of the carrying capacity and limiting factors of ecosystems. The concepts and implications of species biodiversity are explored as well. With the knowledge they have gained, students investigate how human activities affect an ecosystem and use the decision-making model to propose a course of action to enhance its sustainability.

Students will...

S2-1-01 Illustrate and explain how carbon, nitrogen, and oxygen are cycled through an ecosystem.

GLO: D2, D3, D5, E2

S2-1-02 Discuss factors that may disturb biogeochemical cycles.

Include: natural events, human activities.

GLO: A2, C8, D2, D5

S2-1-03 Describe bioaccumulation and explain its potential impact on consumers.

Examples: bioaccumulations of DDT, lead, dioxins, PCBs, mercury...

GLO: B1, D2

S2-1-04 Describe the carrying capacity of an ecosystem.

GLO: D2, E2, E3

S2-1-05 Investigate and discuss various limiting factors that influence population dynamics.

Include: density-dependent and density-independent factors.

GLO: C2, D2, E2, E3

S2-1-06 Construct and interpret graphs of population dynamics.

GLO: C2, C6, C8, D2

S2-1-07 Describe potential consequences of introducing new species and species extinction on an ecosystem.

GLO: E1, E2

S2-1-08 Observe and document a range of organisms that illustrate the biodiversity within a local or regional ecosystem.

GLO: D2, E2, E3

S2-1-09 Explain how the biodiversity of an ecosystem contributes to its sustainability.

GLO: B5, E1

S2-1-10 Investigate how human activities affect an ecosystem and use the decision-making process to propose a course of action to enhance its sustainability.

Include: impact on biogeochemical cycling, population dynamics, and biodiversity.

GLO: B5, C4, C5, C8

Senior 2, Cluster 2: Chemistry in Action

Overview

This cluster provides students with the opportunity to examine the interactions among elements as they form compounds through chemical reactions. Students become familiar with the formulas and naming of binary compounds, and investigate the Law of Conservation of Mass. The recognition that mass is conserved in chemical reactions allows students to balance equations with both words and symbols, and classify them by type. The principles of acid-base chemistry are studied and extended to large-scale environmental interactions. Students investigate the use of chemistry in biological, industrial, and domestic settings, recognizing that chemical use is pervasive in modern society.

Students will...

- S2-2-01 Relate an element's position on the periodic table to its combining capacity (valence).
Include: alkali metals, alkaline earths, chalcogens, halogens, noble gases.
GLO: D3, D4, E1
- S2-2-02 Explain, using the periodic table, how and why elements combine in specific ratios to form compounds.
Include: ionic bonds, covalent bonds.
GLO: D3, E2
- S2-2-03 Write formulas and names of binary ionic compounds.
Include: IUPAC guidelines and rationale for their use.
GLO: A2, C2, D3, E1
- S2-2-04 Write formulas and names for covalent compounds using prefixes.
Include: mono, di, tri, tetra.
GLO: C2, D3, E1
- S2-2-05 Investigate the Law of Conservation of Mass, and recognize that mass is conserved in chemical reactions.
GLO: A2, D3, D4, E3

S2-2-06 Balance chemical equations.

GLO: D3

S2-2-07 Investigate and classify chemical reactions as synthesis, decomposition, single displacement, double displacement, or combustion.

GLO: B1, D4, E4

S2-2-08 Experiment to classify acids and bases using their characteristic properties.

Include: pH, indicators, reactivity with metals.

GLO: D3, E1

S2-2-09 Discuss the occurrence of acids and bases in biological systems, industrial processes, and domestic applications.

Include: environmental, health, and safety issues.

GLO: B2, B3, C1, C8

S2-2-10 Explain how acids and bases interact to form a salt and water in the process of neutralization.

GLO: D3, E2

S2-2-11 Describe the formation and the environmental impact of various types of air pollution.

Examples: acid precipitation, ground-level ozone, airborne particulates, smog; ozone depletion, respiratory ailments, acidified lakes...

GLO: B5, C6, D2, D5

S2-2-12 Investigate technologies that are used to reduce emissions of potential air pollutants.

Examples: catalytic converters in automobiles, smokestack scrubbers, regulation of vehicle emissions, disposal of PCBs from electrical transformers, elimination of CFCs from refrigerants and aerosol propellants...

GLO: A5, B5, C8, E2

Senior 2, Cluster 3: In Motion

Overview

In order to develop an understanding of the physics of motion, the outcomes of this cluster are examined within the context of the automobile. The relationships among displacement, velocity, acceleration, and time are analyzed in conceptual, numerical, graphical, and symbolic modes. Students investigate the qualitative aspects of inertia, force, impulse, and momentum as they relate to automobile safety. The conservation of energy in car collisions and braking distance is explored. Using the knowledge they have gained, students use the decision-making process to address an STSE issue related to safe driving conditions.

Students will...

- S2-3-01 Analyze the relationship among displacement, time, and velocity for an object in uniform motion.
Include: visual, numeric, graphical, symbolic (velocity = $\Delta d/\Delta t$).
GLO: C5, C8, D4, E3
- S2-3-02 Collect displacement data to calculate and graph velocity versus time for an object that is accelerating at a constant rate.
GLO: C5, C8, D4, E3
- S2-3-03 Analyze the relationships among velocity, time, and acceleration for an object that is accelerating at a constant rate.
Include: visual, numeric, graphical, symbolic (acceleration = $\Delta v/\Delta t$).
GLO: C5, C8, D4, E3
- S2-3-04 Outline the historical development of the concepts of force and “natural” motion.
Include: Aristotle, Galileo, Newton’s First Law.
GLO: A2, A4, B1
- S2-3-05 Experiment to illustrate the effects of inertia in car collisions.
Include: distance travelled (of an unrestrained passenger) is proportional to velocity squared ($d \propto v^2$).
GLO: C2, C6, C7, E3

S2-3-06 Describe qualitatively how force is related to motion.

Include: no force; constant force; the relationship among force, mass, and acceleration (Newton's Second Law).

GLO: D4, E3

S2-3-07 Investigate and describe qualitatively Newton's Third Law.

Examples: balloon car, rockets, head-on collision...

GLO: C2, C6, C7, E3

S2-3-08 Define momentum and impulse and qualitatively relate impulse to change in momentum for everyday situations.

Include: car collisions, bumpers, restraints, air bags.

GLO: A5, B1, B2, D4

S2-3-09 Investigate the conservation of energy in a motor vehicle collision.

Include: kinetic energy, potential energy, sound.

GLO: B2, D4, E4

S2-3-10 Investigate conditions that illustrate the effects of friction on motion.

Include: weather conditions, vehicles.

GLO: C2, C5, D4, E2

S2-3-11 Investigate the factors that influence braking distance.

Include: reaction time, friction, condition of driver, speed.

GLO: C2, C3, C6, D4

S2-3-12 Using the relationship among displacement, velocity, and friction ($d = k \cdot v^2$), calculate the braking distance of a motor vehicle.

GLO: C2, C3, C5, C8

S2-3-13 Use the decision-making process to address an STSE issue related to safe driving conditions.

Examples: adverse driving conditions; reaction time and narcotic influences such as blood alcohol level; excessive vehicle speed...

GLO: B3, C4, C5, C8

Senior 2, Cluster 4: Weather Dynamics

Overview

This cluster develops an understanding of the relationships that control weather and climate. An examination of the global energy budget of the Earth through water and heat transfer provides the basis for discussion of severe weather phenomena. Students gather and analyze meteorological data related to a severe weather event, and explore the social, economic, and environmental impact of the event. Evidence that climate change occurs due to natural events and human activities is investigated and evaluated. Students apply their understanding of weather and climate in a discussion of the potential consequences of climate change.

Students will...

S2-4-01 Illustrate the composition and organization of the hydrosphere and the atmosphere.

Include: salt water, fresh water, polar ice caps/glaciers, troposphere, stratosphere.

GLO: D5, E2

S2-4-02 Outline factors influencing the Earth's radiation budget.

Include: solar radiation, cloud cover, surface reflectance (albedo), absorption, latitude.

GLO: D4, D5, E2, E3

S2-4-03 Explain effects of heat transfer within the atmosphere and hydrosphere on the development and movement of wind and ocean currents.

Include: Coriolis effect/convection, prevailing westerlies, jet streams, El Niño.

GLO: A2, D5, E2, E4

S2-4-04 Explain the formation and dynamics of selected severe weather phenomena.

Examples: thunderstorms, tornadoes, blizzards, hurricanes, extreme temperature events, cyclonic storms...

GLO: A2, D5, E1, E4

S2-4-05 Collect, interpret, and analyze meteorological data related to a severe weather event.

Include: meteorological maps, satellite imagery, conditions prior to and following the event.

GLO: C2, C6, C8, D5

S2-4-06 Investigate the social, economic, and environmental impacts of a recent severe weather event.

Include: related consequences of personal and societal decision making.

GLO: B2, B3, B4, C6

S2-4-07 Investigate and evaluate evidence that climate change occurs naturally and can be influenced by human activities.

Include: the use of technology in gathering and interpreting current and historical data.

GLO: A1, A4, D5, E3

S2-4-08 Discuss potential consequences of climate change.

Examples: changes in ocean temperature may affect aquatic populations, higher frequency of severe weather events influencing social and economic activities, scientific debate over nature and degree of change...

GLO: A1, A2, C5, C8