Core Idea ESS2 Vocab

Earth's Systems

How and why is Earth constantly changing?

- Earth
- Dynamic
- interconnected systems—principally the geosphere, hydrosphere, atmosphere, and biosphere
- temporal scale
- spatial scale
- energy flowing
- matter cycling
- motion
- tectonic plates
- cycle
- convection
- Earth's mantle
- outflowing heat
- downward pull of gravity
- land and undersea surface
- weather
- climate
- complex interactions
- sunlight
- ocean
- atmosphere
- clouds
- ice
- land
- life forms
- biosphere
- geosphere
- hydrosphere
- geological time
- geological events and conditions
- evolution of life
- planet
- Water
- Earth's landscape.

ESS2.A: EARTH MATERIALS AND SYSTEMS

How do Earth's major systems interact?

- Earth
- complex system
- interacting subsystems: the geosphere, hydrosphere, atmosphere, and biosphere.
- geosphere
- hot and mostly metallic inner core
- mantle of hot, soft, solid rock
- crust of rock, soil, and sediments
- atmosphere
- hydrosphere (ice, water vapor, and liquid water in the atmosphere, ocean, lakes, streams, soils, and groundwater)
- organism
- biosphere
- life
- geosphere
- human activities
- Earth's systems
- Earth processes
- energy flowing
- matter cycling
- sun
- Earth's interior
- Transfers of energy
- matter
- physical change(s)
- Earth's material(s)
- Solid rocks
- Cooling
- molten rock
- accumulation and consolidation of sediments
- alteration of older rocks by heat, pressure, and fluids
- Physical and chemical interaction
- sediment
- soil
- carbon, water, and nitrogen cycles
- material /matter cycle
- weather
- climate
- tectonic and volcanic processes
- mountain building

- plateaus
- weathering and erosion processes
- transport the products
- landforms
- habitats
- imbalances between the carbon capture and oxygen release that occur in photosynthesis, and the carbon release and oxygen capture that occur in respiration and in the burning of fossil fuels to support human activities
    - imbalance/balance
    - carbon capture
    - oxygen release
    - photosynthesis
    - cellular respiration
    - fossil fuels
    - combustion
- Earth exchanges mass and energy with the rest of the solar system
    - Mass
    - energy
    - solar system
- It gains or loses energy through incoming solar radiation, thermal radiation to space, and gravitational forces exerted by the sun, moon, and planets.
    - incoming solar radiation
    - thermal radiation to space
    - gravitational forces exerted
    - sun
    - moon
    - planets
- Earth gains mass from the impacts of meteoroids and comets and loses mass from the escape of gases into space.
    - Meteoroids
    - comets
    - escape of gases into space.
- Dynamic
- temporal scale
- spatial scale
- stable/stability
- change (slowly) over (long periods of) time
- abrupt change

Grade Band Endpoints for ESS2.A

- Wind
- water
- shape of the land
- weathering

- erosion
- landforms
- habitat (home)
- organisms (living things)
- Earth's major systems
- geosphere (solid and molten rock, soil, and sediments)
- hydrosphere (water and ice)
- atmosphere (air)
- biosphere (living things, including humans)
- Earth's surface materials
- Earth's processes
- ocean
- ecosystems
- 0rganisms
- climate
- Winds
- clouds
- atmosphere
- interact(ions)
- patterns of weather
- Rainfall
- Erosion & weathering (Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around)
- Human activities (affect Earth's systems and their interactions at its surface)
- energy flowing (within and among the planet's systems)
    - (This energy is derived from the sun and Earth's hot interior.)
- matter cycling (within and among the planet's systems)
- Sun
- matter cycles
- chemical and physical changes (in Earth's materials and living organisms)
- scale(s) [that range from microscopic to global in size, and they operate over fractions of a second to billions of years]
- billion
- microscopic (micrometers, um)
- feedback effects
- deep knowledge
- predict(ion)
- change(s)
- impact(s)
- Evidence
- Probes
- seismic waves
- reconstructions of historical changes in Earth's surface

- magnetic field
- physical & chemical processes
- model (of Earth)
- hot, solid inner core
- liquid outer core,
- solid mantle
- crust
- structures known as tectonic plates
- Motions
- plates
- thermal convection
- cycling of matter
- outward flow of energy from Earth's interior
- gravitational movement of denser materialls (toward the interior of the earth)
- geological record
- changes to global and regional climate (could be due to):
    - interactions among changes in the sun's energy output
    - or Earth's orbit
    - tectonic events,
    - ocean circulation,
    - volcanic activity,
    - glaciers,
    - vegetation, and
    - human activities.
    - These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.

ESS2.B: PLATE TECTONICS AND LARGE-SCALE SYSTEM INTERACTIONS

Why do the continents move, and what causes earthquakes and volcanoes?

- Plate tectonics
- unifying theory
- explain(ation)
- rock
- Earth's surface
- geological history
- theory
- evidence (stream(s))
- patterns of earthquake locations
- evidence of ocean floor spreading
- tracking magnetic patterns in undersea rocks
- changes to Earth's magnetic axis data

- data
- warping of the land under loads (such as lakes and ice sheets)
- solid mantle
- density
- continents (lighter and less dense)
- upper-mantle rocks (heavier and denser)
- tectonic plate(s)
- lithosphere (Earth's solid outer layer, i.e., the crust and upper mantle)
- giant convection cell(s)
- matter
- hot inner mantle
- release of energy (from radioactive decay of unstable isotopes within Earth's interior)
- radioactive decay
- unstable isotopes
- cooling
- gravitational downward motion
- dense material
- subduction (one plate being drawn under another)
- continents
- creating and destroying ocean basins
- earthquake(s)
- volcanoe(s)
- mountain range
- plateaus
- geological activity
- plate boundaries

Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a coherent account of its geological history.

- mountain
- deep ocean trenches
- new ocean floor
- mid-ocean ridges
- surface faults
- Earth's crust
- Mineral(s)
- fossil fuels
- energy resources
- plate motions

- plate collisions
- competing constructive and destructive geological processes
- North America
- 4 billion years
- new crustal segments

Grade Band Endpoints for ESS2.B

- rock
- soil
- sand rivers, streams, lakes, and ponds
- Map
- Locations of … occur in patterns.
    - mountain ranges
    - deep ocean trenches
    - ocean floor structures
    - earthquakes
    - volcanoes occur in patterns.
- Pattern(s)
- earthquakes and volcanoes occur in bands
- boundaries between continents and oceans
- Major mountain chains
- land and water features
- Plate tectonics (a unifying theory)
- past and current movements of the rocks at Earth's surface
- framework for understanding
- geological history
- Plate movement(s)
- ocean floor features
- rocks and minerals within Earth's crust
- Maps of
    - ancient land
    - water patterns
    - investigations of rocks
    - fossils assemblages
    - Earth's plates
        - Distances moved
        - collision
        - plates
        - spreading centers
- radioactive decay
- unstable /stable
- isotope(s)
- Earth's crust

- Earth's mantle
- mantle convection
- Plate tectonics
- surface expression of mantle convection

ESS2.C: THE ROLES OF WATER IN EARTH'S SURFACE PROCESSES

How do the properties and movements of water shape Earth's surface and affect its systems?

- Earth
- water planet
- liquid water
- physical and chemical properties of water
- dynamics
- property(ies)
- water properties
    - exceptional capacity to absorb energy
    - store energy
    - release large amounts of energy
    - change of state
    - ability to transmit sunlight
    - expands upon freezing
    - to dissolve and transport many materials;
    - to lower the viscosities and freezing points of the material when mixed with fluid rocks in the mantle.
        - (e.g., ice expansion contributes to rock erosion, ocean thermal capacity contributes to moderating temperature variations).
- Water is found almost everywhere on Earth
    - high in the atmosphere (as water vapor and ice crystals)
    - Low in the atmosphere (precipitation, droplets in clouds)
    - mountain snowcaps and glaciers (solid)
    - running liquid water on the land
    - ocean, and
    - underground
- Energy from the sun and the force of gravity drive the continual cycling of water among these reservoirs.
    - Energy
    - force of gravity
    - continual cycling
    - reservoir(s)
- Sunlight causes evaporation and propels oceanic and atmospheric circulation, which transports water around the globe.
    - Sunlight
    - evaporation

    - oceanic and atmospheric circulation
    - transport(s)
    - globe
- Gravity causes precipitation to fall from clouds and water to flow downward on the land through watersheds.
    - Gravity
    - Precipitation
    - Cloud(s)
    - watersheds
- About 97 percent of Earth's water is in the ocean, and most fresh water is contained in glaciers or underground aquifers; only a tiny fraction of Earth's water is found in streams, lakes, and rivers. The relative availability of water is a major factor in distinguishing habitats for different living organisms.
    - Ocean (97 % of earth's water)
    - fresh water (3 % of earth's water)
        - glaciers
        - underground aquifers
        - streams
        - lakes
        - rivers
        - relative availability of water
- dissolution and formation of Earth's materials (Water participates both in)
- landscapes
- water erosion
- water transport
- water deposition of sediment
- Shoreline waves
- agents of erosion
- millions
- coastline(s) recession/advancement
- kilometers
- sea level
- climate change (e.g., ice ages)

Grade Band Endpoints for ESS2.C

- Water
- Ocean
- Rivers
- Lakes
- solid (ice)
- liquid
- It carries soil and rocks from one place to another and determines the variety of life forms that can live in a particular location (transportation)

- Vapor (as fog or clouds in the atmosphere
- Solid/liquid precipitation (as rain or snow falling from clouds; as ice, snow, and running water on land and in the ocean; and as groundwater beneath the surface
- Groundwater
- Precipitation
- fog
- gravitation monument of water
- downhill
- ocean
- fresh water
- glaciers
- streams
- lakes
- wetlands
- atmosphere
- Water cycles
- Transpiration
- evaporation
- condensation
- crystallization
- precipitation
- complex
- pattern(s)
- Patterns of changes and the movement of water in the atmosphere, determined by
    - winds
    - landforms,
    - ocean temperatures,
    - currents,
    - major determinants of local weather patterns.
- Global movements of water and its changes in form are propelled by
    - sunlight and
    - gravity
- Variation(s)
- Density
- Temperature
- salinity
- global pattern
- ocean currents
- Water's movements—both on the land and underground—cause
    - Weathering
    - erosion
- change
- The abundance of liquid water on Earth's surface

- Waters unique combination of physical and chemical properties
- planetary dynamics
- Water's properties include water's
    - exceptional capacity to absorb energy
    - store energy, and release large amounts of energy
    - transmit sunlight; expand upon freezing;
    - dissolve and transport materials; and
    - lower the viscosities and melting points of rocks

ESS2.D: WEATHER AND CLIMATE

What regulates weather and climate?

- weather
- vary(iation)
- day
- seasonal
- year
- climate
- latitude
- geography
- Weather and climate are shaped by complex interactions involving
    - sunlight,
    - the ocean,
    - the atmosphere,
    - ice,
    - landforms, and
    - living things.
- changes over multiple time scales—
    - from days, weeks, and months for **weather**
    - to years, decades, centuries, and beyond for **climate**.
- The ocean exerts a major influence on weather and climate. It
    - absorbs energy
    - stores large amounts of energy from the sun
    - releases energy very slowly
- … in that way, the ocean
    - **moderates** and
    - **stabilizes** global climates.
- Energy is redistributed globally through
    - ocean **currents** (e.g., the **Gulf Stream**) and
    - also through **atmospheric circulation** (**winds**).
    - Sunlight heats Earth's surface, which in turn heats the atmosphere.
- The resulting **temperature patterns**, together with Earth's **rotation** and the **configuration of continents** and oceans, control the **large-scale patterns** of **atmospheric circulation**.

- **Winds** gain energy and **water vapor** content as they cross hot ocean regions, which can lead to tropical storms.
- "greenhouse effect"
- energy inputs
    - sun
    - radioactive decay in Earth's interior
- balanced by energy loss due to
    - radiation from the upper atmosphere.
- temperature balance occurs is a complex set of
    - absorption,
    - reflection,
    - transmission, and
    - redistribution
- processes in the atmosphere and oceans that determine how long energy stays **trapped** in these systems before being **radiated** away.
- Certain gases in the atmosphere (water vapor, carbon dioxide, methane, and nitrous oxides) which
    - absorbs energy
    - retains energy that radiates from Earth's surface,
    - insulate the planet
- phenomenon
- [what is too cold for life to exist]
- habitable
- change(s) in the atmosphere, such as increases in carbon dioxide, can make regions of Earth too hot to be habitable by many species.

ESS2.D: WEATHER AND CLIMATE

Grade Band Endpoints for ESS2.D

- Weather is the combination of
    - sunlight,
    - wind,
    - snow or rain, and
    - temperature in a particular region at a particular time
- measure
- describe
- record
- patterns
- change over time
- **Weather** is the minute-by-minute to day-by-day **variation** of the **atmosphere**'s condition on a **local scale**.
- make predictions

- **Climate** describes the **ranges** of an area's typical weather conditions and the extent to which those conditions vary over years to centuries.
- **Weather** and **climate** are influenced by
    - interactions involving sunlight,
    - ocean,
    - the atmosphere,
    - ice,
    - landforms,
    - and living things.
- These interactions vary with
    - latitude,
    - altitude, and
    - local and regional geography
- …. all of which can affect
    - oceanic and
    - atmospheric flow patterns
- patterns
- complex(ity)
- probabilistic analysis
- The ocean
    - exerts a major influence on weather and climate
    - by absorbing energy from the sun,
    - releasing it over time, and
    - globally redistributing it through ocean currents.
- **Greenhouse gases** in the atmosphere
    - absorb energy and
    - retain the energy radiated from land and
    - ocean surfaces, thereby
    - regulating Earth's average surface temperature and
    - keeping it habitable
- The foundation for **Earth's global climate system** is the
    - electromagnetic radiation from the sun as well as its
    - reflection of energy,
    - absorption of energy,
    - storage of energy, and
    - redistribution of energy among
        - the atmosphere,
        - ocean, and
        - land systems and
        - this energy's reradiation into space
- Climate change
- **Alteration** of Earth's systems
- Geological **evidence** past **climate** changes were either
    - sudden changes caused by alterations in the atmosphere;

    - longer term changes (e.g., **ice ages**) due to **variations** in **solar output**, Earth's **orbit**, or the orientation of its **axis**; or
    - even more gradual atmospheric changes due to plants and other organisms that captured carbon dioxide and released oxygen.
- time scales
- variable
- millions
- Changes in the atmosphere due to **human activity**
- carbon dioxide
- concentration
- affect /effect
- Global climate **models**
- Knowledge
- physical and chemical processes
- variation
- model(s)
- human-generated greenhouse gases
- biosphere
- natural factors
- complex feedbacks among Earth's systems

ESS2.E: BIOGEOLOGY

How do living organisms alter Earth's processes and structures?

- Evolution
- emergence and extinction of species
- natural and ongoing process
- Earth's dynamic processes
- atmosphere
- range of frequencies of light (that penetrate the atmosphere to Earth's surface)
- Organism
- adaptation
- proliferation of living things have changed the makeup of Earth's
    - geosphere,
    - hydrosphere, and atmosphere
        - over geological time
- **Plants**, **algae**, and **microorganisms** produced most of the **oxygen** (i.e., the O_2)
- photosynthesis
- formation of fossil fuels
- sedimentary rocks
- Microbes
- chemistry of Earth's surface
- nutrient cycling (e.g., of nitrogen)

- bacteria
- global carbon cycle
- global climate
- chemical makeup of the atmosphere
- Greenhouse gases
- Matter reservoirs represented by the
    - ocean,
    - land,
    - life, and
    - atmosphere
- The abundance of **carbon** in the atmosphere
- **ocean floor** accumulation of **marine sediments**
- accumulation of plant **biomass**;
- atmospheric carbon
- deforestation
- **combustion** of **fossil fuels**
- influence life
- co-evolution

Grade Band Endpoints for ESS2.E

- Plants
- animals (including humans)
- land
- water
- live
- growth
- Living things
- physical characteristics of their regions (e.g., plants' roots hold soil in place, beaver shelters and human-built dams alter the flow of water, plants' respiration affects the air).
- Rock
- Mineral
- **Evolution** is shaped by Earth's varying **geological conditions**.
- Sudden **changes** in conditions (e.g., meteor impacts, major volcanic eruptions)
- mass extinctions
- geological time
- **rates** of **weathering** and **erosion** of land surfaces
- altered the composition of Earth's **soils** and **atmosphere**,
- **distribution** of water in the **hydrosphere**.
- dynamic and delicate feedbacks
- biosphere
- co-evolution of Earth's surface