8th Grade Earth Science Planning and Curriculum Guide Canton School District

**Standards Addressed**

* MS-ESS1-1 through ESS1-3: Earth-Sun-Moon systems, Gravity, and Scale properties in the Solar System.
* MS-ESS2-1 through ESS2-6: Geoscience processes and Earth’s surface, Earth’s natural cycles, Earth’s age and history, Cycling of water on Earth, Weather, and Regional climates.
* MS-ESS3-1 through ESS3-5: Mineral, energy, and groundwater resources, Natural hazards, Human impacts on environment, Population and resources, and Climate change.
* MS-PS1-1 through PS1-6: Atomic composition, Chemical reactions, Synthetic and natural resources, Phase changes, Conservation of Mass, and Thermal energy and chemical reactions.

**Unit Breakdown \*Roughly 6 weeks to less a unit \*Quiz following each section, unit open exams.**

1. Intro to Earth Science (No Khan Videos)
   1. Introduction to Earth Sciences
   2. Observational Skills
   3. Scientific Processes
2. Astronomy \*Khan Video supplements
   1. Motion and Models
   2. Galaxies and Gravity
   3. Stars and the Solar System
   4. Seasons
   5. Moon and its phases
   6. Solar Eclipses
3. Weather and Climate \*Khan Video Supplements
   1. Water Cycle
   2. Weather
   3. Global winds and currents
   4. Regional climates
4. Geosphere \*Khan Video Supplements
   1. Rock Cycle
   2. Fossils and Rock Layers
   3. Plate Tectonics
   4. Weathering and Erosion
5. Earth and Society \*Khan Video Supplements
   1. Natural Resources
   2. Natural Hazards
   3. Human impacts on environment
   4. Earth’s changing climate

Unit One Notes Guide

* Earth Science Field
  + Geology
  + Oceanography
  + Meteorology
  + Astronomy
* Why study?
  + Natural Hazards
  + Natural Resources
  + Impact on Earth processes
  + Understanding geologic time
* Process of Science
  + Hypothesis vs Theory
  + Method of science
    - Pose a question
    - Collect background research
    - Construct a hypothesis (if, then and testable)
    - Experiment (with proper variables)
    - Analyze data (and possibly try again)
    - Share results
* Earth as a system
  + Interacting spheres
    - Hydrosphere
    - Atmosphere
    - Biosphere
    - Geosphere
      * Three layers based on physical and chemical properties.
        + Core, Mantle, and crust (**density** separates them)
        + Upper mantle and crust is broken down by physical properties:

Lithosphere

Asthenosphere

* + Systems are driven by the Sun and Earth’s interior
* Observing Earth’s Surface
  + What can we observe?
    - Color (red?)
    - Shape
    - Layers (Bedding)
    - Fractures
    - Debris
  + Strategies to Observe
    - Focus on one part of the landscape at a time
    - Note color
    - Pinpoint areas resistant to erosion
    - ID layers and directions of layers
    - Shape of eroded rocks
    - Sketch the details
    - Infer the environment in which the landscape formed.
    - Arrange parts into a progression on how it changed over time.
      * Principles: Youngest layer on top, geologic features are younger than a rock it crosscuts, younger rocks can include pieces of older rock, and younger magma can bake or change older rocks.
  + Visualizing Earth’s Surface
    - Four maps
      * Shaded relief
      * Topographic
      * Satellite
      * Geologic

Assessment: Crater Formation (HS book) and Investigation 1

Unit 2: Earth in Space

* What makes Earth habitable?
  + Lies in the habitable zone. Right size, time, and place relative to our star.
* Earth-Moon-Sun
  + Time and Seasons
    - Spin on its axis measures time. (Rotation)
    - Time zones result from the rate of the spin. (15 degrees per hour)
  + Revolution determines the date.
    - Motion of Earth’s elliptical orbit around the Sun.
  + Tilt determines seasons (Inquiry Lab)
    - Determined by the angle of the sun’s rays.
    - Solstice: occurs when Earth’s rotational axis is tilted directly toward the Sun or away from the Sun.
    - Equinoxes: Earth’s rotational axis is perpendicular to a line drawn from the center of Earth to the center of the Sun.
* The Solar System
  + Models of the Solar System
    - Geocentric model
      * Earth is the center of the solar system (observations of planets moving backwards worked against this model)
    - Heliocentric model
      * Sun is the center of the solar system. (Galileo and Copernicus)
  + Classifying the Planets
    - Terrestrial Planets or Inner Planets
      * Similar to Earth in size, structure and composition.
    - Jovian planets (Giant planets) or Outer Planets
* Origin of the Solar System
  + Explosion of a nearby star caused a nebula (cloud of gas and dust) to increase in density.
  + Gravity pulls dust and gas towards the center and the spinning increases forming a disc and temperature increased to a point where nuclear reactions occurred to form the Sun. (Discuss Gravity in depth)
  + Extrasolar systems are systems that include a star and planets other than our own. (350+ as of 2010)
* Inner Planets (Infographics…...project learning)
  + Mercury, Venus, Earth, Mars
  + Features vary in atmosphere, temperature, surface features, etc.
  + Gullies = water erosion, Craters = meteorite impact, Basins = shallow sea, Sediment layers in cliffs = deposition by water or wind, and Volcanoes (inquiry lab prior to infographic assignment)
* Outer Planets (water exists only as ice)
  + Jupiter, Saturn, Uranus, and Neptune.
* Dwarf Planets (nearly round objects in orbit around the Sun, but have not cleared debris in their orbit)
  + Pluto, Eris, and Ceres.
* Other Objects
  + Comets: composed of dust and rock particles, frozen water, methane, and ammonia.
  + Asteroids: Rocky objects formed from material similar to a planet.
  + Meteoroids: Sand to boulder sized objects in the solar system.
  + Sedna: Distant planetoid, smaller than Pluto but has an elliptical orbit. (Mystery)
* Life in the Solar System
  + What qualities are necessary for sustaining life?
* Stars and Galaxies
  + Observations
    - Constellations (groups of stars)
    - Telescopes (refracting, reflecting, or radio)
  + The Light year
    - Distance light travels in one year. (9.5 trillion kilometers)
    - Light travels at 300,000 km/s
  + Spectroscopes
    - Separate light into its component wavelengths and can tell you the components of a star.
* Evolution of Stars
  + Forms from a nebula. Temperature reaches 1 million Kelvin to form a protostar and 10 million to create a star.
  + HR Diagram (Activity…discussion based)
    - Relationship between brightness and temperature of stars.
    - 90% are Main Sequence Stars
    - Includes stars that are fusing hydrogen into helium. Maintain equilibrium (outward pressure exerted by the fusion reactions equals the inward pull of gravity)
    - What happens when equilibrium ends?
      * Depends on mass, but it ends when all of the hydrogen at its core is used up.
      * Average mass (like the Sun) become red giants, then white dwarfs, and finally a black dwarf.
      * Red giants: star’s core heats and outer layers expand and cool.
      * White dwarf: Core temperature reaches 100 million K and helium fuses to form carbon. Layers escape to space and a hot, dense core is left behind.
      * Larger mass become supergiants and then neutron stars or black holes.
      * Supergiants are the same as giants…just much larger and hotter so they fuse into heavier elements such as Iron.
      * Supernova: Iron accumulates in the core and the star can no longer support itself causing the core to collapse and a huge amount of energy is released. (giant explosion) All that is left is a ball of neutrons called a neutron star.
      * Blackholes are areas in space so dense that nothing can escape the pull of gravity.
      * Smaller mass remain in the main sequence as red dwarfs.
* Galaxies and Cosmology
  + Galaxy: large group of stars, dust, and gas held together by gravity.
    - Milky Way Galaxy (200-400 billion stars), Andromeda Galaxy is the next closes at 2.5 million light years.
  + Classified by shapes
    - Spiral, Elliptical, and Irregular
  + Local Group
    - Group of 50 galaxies that we belong to. Stretches 10 million light years.
* Cosmology
* Study of how the universe began, how it continues to change, and what it is made of.
* Big Bang Theory (theory on the origin of the Universe)
  + All matter and energy in the universe were compressed into a single point, which began to expand 13.7 billion years ago.
* Evidence
  + Cosmic background radiation (residual radiation from the origin of the Universe)
  + Doppler Effect (Lab)
  + Light wave frequency changes as an object moves towards or away a fixed point.
  + Redshift = getting further away

Unit 3: Weather and Climate

* Introduction
  + Weather is a daily description of temperature, pressure, and precipitation conditions of the atmosphere for a specific place.
    - Temp, Air pressure, Wind, Humidity, Relative humidity, Dew point, clouds, precipitation
  + Climate is a longer term (30 years) view of the same factors.
* Atmosphere
  + Envelope of gases surrounding the planet. (if Earth was the size of a basketball, the atmosphere would be as thick as a sheet of paper)
  + Shields planet from meteors and blocks out most of the Sun’s harmful UV radiation.
  + Regulates climates and allows surface temperatures to be suitable for life to exist in the troposphere (lowest layer of atmosphere)
  + Layers (Temp and air pressure decrease as you move up)
    - Troposphere: layer in which weather occurs, only later where terrestrial organisms can survived, 12 miles above sea level at the equator and 4 miles at the poles.
    - Stratosphere: layer above the troposphere, nothing lives in this layer but it has a direct impact on life at the surface, lower stratosphere contains high amounts of ozone (ozone layer) which absorbs 95% of harmful UV radiation.
    - Mesosphere, thermosphere, exosphere are the remaining layers that help protect Earth from the extremes of space. Houses the ionosphere where radio waves travel and auroras occur.
* Greenhouse Effect (Balance of absorption and reflection)
  + Solar energy warms the troposphere as it reflects from the geosphere and interacts with carbon dioxide, methane, water vapor (hydrosphere and biosphere), and other gases in the atmosphere.
  + Allows the Earth to be warm enough to support life.
* Important cycles within the atmosphere
  + Hydrologic Cycle
    - Collects, purifies, and distributes Earth’s fixed supply of water. Influences all other nutrient cycles.
    - Powered by the sun.
    - Water moves via: evaporation, condensation, precipitation, transpiration (plants), surface runoff, groundwater (aquifers)
    - Easily polluted due to ability to dissolve substances but purifies as it evaporates.
    - 0.024% is available as liquid fresh water to use.
    - Humans alter in 3 major ways:
      * People drain and fill wetlands for farming and urban development. (Naturally wetlands act as flood control to hold overflows of water)
      * Withdraw fresh water from sources faster than natural processes can replace it. (water table)
      * Clear vegetation from land for agriculture, mining, road building, and other activities thus increasing runoff and reducing infiltration to recharge groundwater supplies.
  + Carbon Cycle
    - Carbon is the building block of all organic compounds needed for life.
    - In this cycle different compounds of carbon circulate through the Earth’s spheres.
    - Carbon dioxide is a key component to the Carbon cycle.
      * Producers move it from the atmosphere to the biosphere via photosynthesis and consumers release it back to the atmosphere via respiration.
      * Remains in atmosphere for up to 100 years and has a major role on Earth’s temperatures via greenhouse effect.
      * Also stored in marine sediment over millions of years forming coal, oil, and natural gas.
      * Carbon sinks vs Carbon source.
* Weather Maps (Khan Video)
  + Low Pressure Systems (L)
    - Winds and clouds flow counterclockwise around these systems.
    - Lift and cool moist area causing rain or other forms of unsettled weather.
  + High Pressure systems (H)
    - Circulates clockwise and winds move out from the center. Accompanied by sinking air and fair weather.
  + Fronts
    - Blue lines indicate masses of cold air with edges indicating direction of movement. (pushes warm air up, severe storms)
    - Red lines indicate masses of warm air. (rises over cold air, steady rain or snow and many clouds)
    - Others
      * Stationary fronts occur when approaching fronts stall with two temps of air masses on either side. Leads to cloudy skies and light rain.
      * Occluded fronts occur when a fast moving cold front catches up with a slow moving warm front and blocks the front. Leads to precipitation.
* Winds (Khan Video)
  + Movement of air in the atmosphere. Driven by pressure differences due to uneven solar heating.
  + Pressure decreases with altitude due to less gas molecules thus exerting less of a force on the surface.
  + Winds flow from high pressure (air sinks) areas to low pressure areas (air rises).
  + Discuss various wind patterns and the Coriolis Effect.
    - Trade winds (doldrums)
    - Westerlies
    - Polar easterlies
    - Jet stream (most influential)
* Oceans and Climate
  + Main Ocean Surface Currents
  + Fast moving horizontal flows of shallow ocean water that extend to a depth of 1,000 m. Impact 20% of the ocean and are driven by wind or deflection by continents. Types: Print Handout pg. 374 part A and B)
  + Temperature of surface currents and the wind pattern can control local climates.
    - Ex: warm East Australian current flows south along the east coast. Easterly winds pick up moisture from the current and flow over Australia leading to rain along the east coast.
  + Deep Ocean Currents
    - Deep water conveyor driven by density variations due to differences in temperature and salinity. (Demo) Cold or super saline water is denser.
    - Takes water about 1,000 years to complete the cycle. (pg. 374 handout)
    - Maintain land temperatures and rainfall along coasts and can cause upwelling in areas which brings deep sea derived nutrients to the surface and makes marine life in that area rich.
* El Nino and La Nina
  + El Nino
    - Occurs when warmer than average ocean surface temperatures occur in the central and east central equatorial Pacific.
    - Leads to increased evaporation and more rainfall. In the U.S. this is expressed by warmer than normal winters in the Midwest.
  + La Nina
    - Occurs when the equatorial counter current weakens, and there is an increase in easterly winds. High temperature waters are restricted to the western and central Pacific.
    - Doesn’t affect the Midwest.
* Precipitation
  + Takes the form of water drops, snowflakes, and hail. Typically occurs when moisture-rich air lifts and cools in the atmosphere.
  + What controls the physical states of water?
    - Evaporation and Condensation
    - Water exists in vapor, liquid, or ice at the surface but is dependent on atmospheric pressure and temperature. (Graph pg. 370)
    - As water vapor condenses it forms microdrops which form together to form raindrops. Can also evaporate while still in the air forming crystals of snow and ice (hail).
    - Snow and ice form at cooler atmospheric conditions and can fall to the surface or remain in clouds.
    - Energy is released as rain or snow forms. (heats air) Heat is absorbed when ice melts or water evaporates causing the air to cool.
    - Impacts large scale atmospheric circulation. Handout Part C on pg. 371
* Clouds
  + Crucial to climate systems by regulating solar energy and transferring energy into the atmosphere.
  + Form when a mass of warm, moist air expands and cools. Causes humidity to rise until it reaches 100% at which point water vapor condenses to form tiny water droplets that attach to airborne particles and create clouds. (Demo in bottle.)
  + Types (Handout Diagram):
    - High level: Cirrus, Cirrostatus, Cirrocumulus
    - Mid level: Altocumulus, Altostratus
    - Low level: Nimbostratus, Stratocumulus
    - Vertically developed: Fair weather cumulus, Cumulonimbus
    - Others: Billow, Mammatus, Orographic, Pileus, and Contrails
    - Fog and Mist are composed of mini water droplets suspended in air. Essentially they are clouds close to the ground. Fog is denser than mist.
* Short Term Climatic Variations (Khan Video)
  + Overall climate is controlled by latitude, elevation, ocean currents, prevailing winds, precipitation, and other factors.
  + However, many regions have dramatic shifts in overall climate from year to year.
  + Short Term Variations
    - Monsoon
      * Change in prevailing wind direction from one season to another leading to torrential rainstorms. (India)
    - Ex: During the summer, the Gobi Desert heats up due to more direct sunlight causing a low pressure area as heated air rises. This drives winds from the Indian Ocean inland where they dump immense rains onto India as the winds move inland.
    - Droughts
      * Extended period of below-average precipitation that places stress on plants and animals and erodes the land as it dries out. Can also lead to water shortages. Three causes:
      * Unusual shifts in wind direction that bring dry air over a region.
      * Atypical weather patterns such as persistent high pressure area with sinking air.
      * Change in direction or strength of ocean current such as La Nina.
    - Seasons
      * Seasons form due to Earth’s tilt of 23.5 degrees as it orbits the Sun.
      * Summer = tilted towards the Sun and more direct sunlight.
      * Winter = opposite.
      * Fall and Spring = neither tilted towards or away.
* Climate Regions (Biomes) on Earth
  + Rain Forests
    - Characterized by high annual rainfall, no freezing temperatures, and a rich collection of plant and animal species. Tropical or Temperate Rain Forests.
    - Structure:
      * Canopy: Umbrella of treetops that capture most of the sunlight and contain most of the species.
      * Understory: Shaded so plants are short with broad leaves.
      * Forest Floor: Dark and organic debris decomposes rapidly. Highly leached soil so little nutrients are present.
      * Most of the rainforests lie in the tropics along the equator and intertropical Convergence Zone. (map)
    - Role in Ecology
      * Major nutrient recycling source
      * Carbon dioxide uptake (buffer against climate change)
      * Diversity storehouse (5 million plus species)
      * Provide shade and keep ground sheltered and cooler.
    - Threats
      * Deforestation: 2.5 acres per second.
    - Driven by economic pressure for:
    - Commercial logging via clearcutting
    - Mining copper, gold, oil, and others.
    - Cattle ranchers
    - Highways and buildings
    - Dam construction
    - Subsistence farming (poor farming)
* Deserts
  + Arid regions that receive less precipitation than it loses to evaporation or other processes. Typically have less than 10 inches of rainfall per year. Vegetation covers less than 15% of the ground.
  + Can also form in rain shadows of mountain ranges OR in cold, dry polar regions.
  + How do they form?
    - Coastal deserts form where cold, upwelling ocean currents cool air and decrease the ability to hold moisture.
    - Polar deserts form where cold, dry air prevails and any moisture is frozen for the year.
    - Continental deserts form far from sources of moisture or where prevailing dry winds blow toward the sea.
    - Rain Shadow Deserts form as wind with moisture hits a mountain chain. As the air rises over the mountain it cools and releases rain, but as it descends on the downwind side of the mountain it dries and heats up.
  + Desertification
    - The process of converting other lands to desert due to extended periods of drought, overgrazing by livestock, poor farming techniques, and diversion of surface water.
    - Loss of plants = increased erosion. Grassland biomes at greatest risk.
    - Other terrestrial biomes Include:
* Boreal Forests, Tundra, Temperate forests, temperate grasslands, tropical grasslands, and chaparral (most at risk for wildfires).

Unit 4: The Geosphere

* Minerals vs Rocks
* Building Blocks of Minerals: Atoms
  + Atom and its various models
  + Today’s model: Protons, Electrons, Neutrons
  + Elements
    - Natural vs Synthetic
    - Periodic Table (Mendeleev)
    - Properties of the periodic table: atomic number, mass number, valence electrons
  + Chemical Bonds
    - Octet Rule and Stability (Reason for bonding)
    - Ionic vs Covalent vs Metallic Bonds
  + Physical vs Chemical properties
    - Physical and chemical changes
* Mineral Properties (Qualitative vs Quantitative)
  + Color, Luster (metallic, waxy, silky, pearly, or glassy), Streak, Hardness (Moh’s scale), Cleavage or Fracture, Density, Special properties (reacts with acid, fluorescent, magnetic, odor, or texture)
  + Two groups: Silicates or Non-silicates
    - 98% of minerals contain Si, Fe, Mg, Al, O, K, Na, and C.
* The Rocks
  + Properties are based on texture and size of grains and composition.
  + Types: Igneous, Metamorphic, and sedimentary.
    - Driven by rock cycle (pg. 59/handout my book)
  + Igneous Rocks
    - Volcanic rocks that are extrusive or intrusive. (Intrusive tend to have crystals)
    - Properties used to ID igneous rocks
      * Texture (fine or coarse grained, glassy, porphyritic, or vesicular) Can indicate cooling history.
      * Color (felsic is lighter, more silica and mafic is darker, less silica) \*Obsidian is the exception
  + Sedimentary Rocks
    - Driven by physical and chemical weathering creating sediment that is compacted and cemented by pressure.
    - Properties used to ID
      * Clastic Rocks (organized by size and shape of clasts, ex: Breccia vs Conglomerate)
      * Chemical Rocks (form from chemical reactions with water, ex: Rock salt)
      * Biochemical Rocks (form via organism remains, contain carbon, ex: limestone and coal)
  + Metamorphic Rocks
    - Formed via metamorphism due to heat and pressure. Changes structure and composition of rocks via plastic deformation.
    - Properties used to ID
      * Foliation (layers) vs Non-foliated (no layers)
        + Lower metamorphism = more dense = more narrow layers or non-foliation.
* Dating and Geologic Time
  + Fossils (Paleontology)
    - Based on catastrophism and uniformitarianism
    - Formation of Fossils
      * Hard parts and rapid burial increase chances of fossils being created.
      * Types
        + Preserved (amber, ice, and tar)
        + Carbon film
        + Mineral replacement (petrified wood)
        + Mold vs Cast (mold is impression while case is filled in)
        + Trace fossil
      * Can indicate ancient environments in an area (implement for South Dakota)
  + Relative Dating (dating features by comparison)
    - Based on 5 principles
      * Superposition (top is youngest, bottom is oldest)
      * Original horizontality (everything lays in horizontal layers first)
      * Lateral continuity (all layers lay uninterrupted in all directions first)
      * Inclusions (pieces of rock within other rock or formations are older)
      * Cross cutting relations (things that cut across are younger than what they cut through)
    - Unconformities (events that represent a change in time or landscape)
      * Disconformity (eroded layers of rock), Angular unconformity (angled layers followed by horizontal layers), Nonconformity (sediment layers on top of metamorphic or igneous)
    - Correlation
      * Matching rocks and fossils from separate areas
      * Index fossils
  + Absolute Dating (dating features with numerical ages via atoms and their isotopes)
    - Use of radioactive decay and half lives of isotopes.
    - C-14 used for organic material (HL is 5,730 years)
    - Rocks use U-235, K-40, U-238, Th-232, Rb-87 for rocks because their longer half lives. (Used to indicate the Earth is 4.54 billion years old)
* Geologic Time (Universe began 13.8 bya with the Big Bang)
* Eras: largest time intervals and are marked by major changes in fossils (disappearance of them) which correlates with mass extinctions.
  + Cenozoic (youngest)
    - Boundary marked by K-T Extinction. (Meteor)
  + Mesozoic
    - Boundary marked by the Great Dying Extinction.
  + Paleozoic
    - Boundary marked by the Cambrian Explosion (burst in biodiversity)
  + Precambrian
* Periods: subdivisions of each era.
  + Cenozoic
    - Quaternary, Neogene, Paleogene
  + Mesozoic
    - Cretaceous, Jurassic, and Triassic.
  + Paleozoic (time of supercontinents: Gondwana, Laurasia, and Pangea)
    - Permian, Pennsylvanian and Mississippian (Carboniferous), Devonian, Silurian, Ordovician, and Cambrian.
* Plate Tectonics
  + Earthquakes and Volcanoes and their relationship to Plate Tectonics
    - Show a map of EQ locations
    - What patterns do you notice? Which regions have many EQs and which have few? Are EQs associated with certain types of features?
    - Repeat but with a map of volcano locations. How does it compare to the EQ map?
    - What causes tectonic activity to occur in belts?
      * \*Show a map of Earth’s plates.
      * What do you notice about it compared to the location of EQs and Volcanoes in the previous maps?
      * Referred to as tectonic activity and those occur in highly active regions.
  + Theory of Plate Tectonics states that the outer layer, the lithosphere, is broken into a dozen or so rigid pieces (plates).
    - Plates move relative to one another in one of three boundaries.
    - Divergent boundary
    - Convergent boundary
    - Transform boundary (slide past each other)
      * \*Use the map on pg. 57. Use the various maps we have explored to determine whether each type of plate boundary has the following features: EQs, Volcanoes, Mountain belts, Mid Ocean Ridges, or Ocean Trenches. (**Formative Assessment: Print Slide)**
  + Divergent Boundaries
    - Occur at Mid Ocean Ridges. Common site of small to medium EQs and submarine volcanism.
    - Events at MORs in the ocean
      * Occur in oceanic plates where two oceanic plates are formed and move apart. Rifts run along the axis.
      * Magma (molten rock) rises beneath the rift and forms the new plate and solidifies at depth. Causes the MOR to be elevated.
    - Events at Divergence in Continents
      * Called continental rifting (Great Rift Valley)
      * Magma rises into and pushes up the crust causing uplift.
        + If it continues to spread until the plate splits into two, an ocean basic can form. (Red Sea formation) \*If it continues over millions of years it forms a large ocean basic. (Formation of Atlantic Ocean)
  + Convergent Boundaries
    - Two Oceanic Plates
      * One plate move below the other (subduction) and pulls part of the Earth plate area down (subduction zone). Most large EQs occur here.
      * Oceanic trench forms as well as an island arc. (Picture)
    - Oceanic and Continental Plate
      * Oceanic plate always subducts below the continental plate. (More dense)
      * Leads to an oceanic trench and high volcanic mountain chains on the overriding continent. (Ring of Fire)
    - Two Continental Plates
      * Typically neither subducts and a continental collision occurs forcing both plates to uplift and form high mountain chains. (Himalayas)
      * Mountains form from collisions, erosion, uplift, and volcanic and tectonic activity.
      * Types (Mountain Range activity pg. 275 Canton book)
        + Folded, Fault-Block, Uplifted, and volcanic
  + Events at Transform Boundaries
    - Produce zig zag patterns on the ocean floor and are connected by transform faults. (pic on pg. 62 and pg. 63)
    - Ex: San Andreas Fault
  + What moves the plates? (Move 1 to 15 cm/yr)
    - Basic concept: Driving force must exceed the resisting forces.
    - Three Driving Forces
      * Slab Pull: Subducting plate is more dense so gravity pulls the plate downward and moves faster.
      * Ridge Push: Gravity causes plates to slide away from high ridges and push plates outward. (MOR)
      * Mantle Convection: Hot material rises due to low density and colder material sinks because of high density. Constant cycle in asthenosphere.
  + What geologic features does plate tectonics help explain?
    - Seafloor Spreading (Picture)
      * Oceanic crust near MOR will be thinner and younger. (Reversed polarity is also seen in the seafloor.)
    - Continental Drift
      * Alfred Wegner proposed that the continents have drifted over time to their current positions and were once joined together.
      * What evidence, besides pieces of the continents fitting together, would support this theory?
    - Island and Seamount Chains (submarine mountains)
      * Hawaii
      * Big Island is the beginning of the chain and continues NW 2,000 km all the way to Midway Island. (Picture)
      * Only island that has active volcanic activity is the Big Island, while the others have volcanic rocks. What conclusion can we make?
      * Explanation
        + Island chain was formed by volcanism and are near sites that are referred to as hot spots (abnormally high temperature regions).
        + Hot spots are stationary and the upper plate moves over. The chain of islands and seamounts indicates the direction of the plate’s motion. The speed at which the plate moves determines if one island appears along the chain or a cluster of islands.
  + Connections 3.9: Why is South America Lopsided?
    - What is the present setting of South American and what are its geologic features? (Hand out pic from pg. 68)
    - What is the geometry of the South American Plate and its Neighbors? (Hand out top image from pg. 69) What does this tell us about the edges of South America?
    - How did South America Develop Its Present Plate-Tectonic Situation?
    - Where was it in the past? When did it become a separate continent and when did the current boundaries develop? (2.5 cm/yr is the current rate of spreading)
    - Investigation 3.10: Where is the Safest Place to Live?
* Weathering and Erosion
  + Physical Processes that affect rocks near the surface
    - Physical or chemical weathering which includes the breaking of rocks into smaller fragments or are attacked by chemical reactions.
    - Erosion moves small fragments from original site.
  + Factors that play a role in weathering
    - Fracturing
    - Thermal expansion
    - Frost wedging
    - Mineral wedging via precipitation
    - Burrowing organisms
    - Root wedging
  + Chemical Processes
    - Main agents are water and weak acids (carbonic acid) formed in water. Dissolve rock, loosen mineral grains, form clay materials, and widen fractures.
    - Oxygen can react with some minerals to change the oxidation state of an ion such as Iron. (Changes the charge of the ion….aka rusting.)
    - Hydrolysis converts minerals to clay when a reaction occurs with water.
  + Factors that influence weathering
    - Characteristics of a rock: composition, chemical bonding, variation in composition (differential weathering), and surface area, and discontinuities (fractures, bedding, etc.).
    - Climate (warm and humid = more)
    - Hillslope Orientation (slopes sheltered from sunlight = more due to more plant growth and moisture control)
    - Steepness of Slopes (gentle slopes = more due to longer time weathering can occur) (Topography)
    - Time
  + Soil **(Soil Study Lab)**
    - Unconsolidated material above the bedrock and contains both mineral and organic matter along with air and water. Consists of different zones called horizons.
      * O horizon: surface accumulation of organic debris.
      * A horizon: topsoil, composed of dark gray, brown, or black organic material.
      * E horizon: light colored, leached zone. Lacks organic matter.
      * B horizon: contains little organic material, but is red in color due to iron oxide. Drier climates may appear whitish.
      * C horizon: weathered bedrock or unconsolidated sediment.
      * Bedrock
      * Soil profiles vary for different climates. (Show picture)
  + Important properties include: Color, texture, structure, consistency, infiltration, soil moisture, pH, fertility, and temperature.
  + Slopes and Stability
    - Mass wasting is the downward movement of material on slopes under the force of gravity. Can proceed slowly or quickly depending on various conditions.
    - Shear component becomes larger than normal component and overcomes friction to slide.
    - Steepest angle grains can remain stable at is the angle of repose.
    - Slope Stability is controlled by:
      * Angle of repose for the material
      * Amount of water (minor = stronger, oversaturation = weaker)
      * Fractures, cleavage, and bedding reduce strength.
      * Frost heaving
    - Slope Failure
      * Occurs when a slope is too steep for its material to resist the pull of gravity. Rapid = landslide
    - Triggers
      * Precipitation, hillslope overload, modification of slopes by humans, volcanic eruptions, and EQs.
    - Investigation 15.14: Which areas have the highest risk of slope failure?
  + Sea Level Changes (occurred many times, driven by climate or tectonics)
    - Sea Level Rises
      * Submergent coasts form where the land has been covered by the sea due to rise in sea level. Over time river valleys flood and form estuaries. (river flooded by the sea)
    - Sea Level Falls
      * Emergent coasts form where sea retreated. Marine terraces are shown where waves had cut notches. May see exposed reefs.
    - Causes
      * Continental Glaciation (more glaciers = lower sea level)
    - Seafloor Spreading Rate (slower = lower sea level due to smaller Mid Ocean Ridges)
    - Ocean Temperature (colder = lower due to contraction of water)
  + Glaciers
  + Moving masses of ice that range from huge ice sheets that cover regions to smaller glaciers restricted to mountains. Characteristics include:
    - Form where snow and ice accumulate faster than melting. High elevations and latitudes with gradual slopes.
    - As they flow (due to ice not being strong enough to support its own weight against gravity), the upper surface fractures due to stress. (crevasse) Ex: Everest Crevasses. As it moves it plucks pieces of rock and carries rocks of all sizes to a location where it melts.
    - Blocks of ice can fall from glaciers that meet bodies of water forming icebergs (90% under the surface) or it can form an ice shelf.
  + Geologic Features of Glaciers
    - U-shaped valleys and Hanging Valleys are two distinct characteristics of glacial activity.
    - Moraines
    - Sediment carried and deposited by glaciers.
    - Lateral and Terminal moraines. (Demo with water bottle and soil)
    - Kettle Lakes
  + **Rivers and Streams**
    - Rivers and streams carry flowing water through a single channel or interconnected channels fed by tributaries. Begin at the headwaters and end at the mouth. Discharge refers to the amount of water that flows over a given amount of time. Sediment load refers to the amount of sediment carried by the river, which includes material chemically dissolved.
      * Headwaters = largest gradient. (Example Part A)
      * Channel Size
      * Discharge
      * Total sediment load
  + Why do rivers and streams have curves? **(River Table Lab)**
    - Braided rivers are characterized by networks of interweaving curving channels, but the overall channel is fairly straight.
    - Low sinuosity rivers are characterized by a single channel with a gentle curve.
    - Meandering rivers have channels that are very curved.
      * Inside of the bends have lower water velocity and sediment is deposited forming point bars.
      * Outside of the bends have higher velocities and the force of water is directed to the outside of the bend causing steep erosion into a river bank called a cut bank.
  + Various Geologic River Features
    - Floodplains
    - River Terraces
    - Levees

**Unit 5 Earth and Society**

* Natural Resources
  + What are Earth’s Mineral Resources and How Long Might They Last?
    - Mineral Resources
    - Reserves are portions of mineral resources that are economically and technically feasible for mining. (Ores)
    - Depletion Time
      * Time it takes to use a about 80% of the reserves of a mineral.
      * Depletion Curves Vary
        + Short Depletion Times: mine, use, throw away; no discoveries, no rising prices.
        + Mid-Range Depletion Times: Recycle; increase reserves via improved mining, higher prices, and new discoveries.
        + Long Range Depletion Times: Recycle, reuse, reduce consumption, increase reserves via improved technology, higher prices, new discoveries.
    - What are the effects of using mineral resources?
      * Mining Techniques
        + Surface Mining

Vegetation, soil, and rock overlying a mineral deposit are cleared away. Waste material (overburden) is deposited in piles called spoils.

90% of nonfuel minerals and 60% of coal in United States.

* + - * + Types of Surface Mining: Open pit, strip, and mountaintop removal.
      * Subsurface Mining
        + Deep deposits of minerals are removed via tunnels and shafts.
        + Disturbs less than 1/10th as much land as surface mining.
        + Produces less waste material.
        + Can cause cave-ins, explosions, fires, lung disease for works, and can create subsidence.
    - What is net energy and why is it important?
      * Kinetic vs Potential energy
      * Commercial Energy
        + Energy sold in the marketplace
        + Renewable (wind, water, solar, biomass, and geothermal) or Nonrenewable (fossil fuels and nuclear energy)
      * Net Energy
        + Amount of high quality energy available from a given quantity of an energy resource minus the high quality energy needed to make that energy resource available.
        + Net energy = energy output – energy input (Most important evaluation tool to long term economic usefulness)
        + Low net energy resources are costly to bring to market. (Subsidies can hide the true cost)
  + Fossil Fuels
    - Crude Oil
      * Mixture of hydrocarbons and other compounds. Black, gooey liquid that is extremely flammable.
      * Forms over millions of years from decayed ancient organisms subjected to intense heat and pressure. (Geology explanation, PPT)
      * Found in shale rock.
      * Heated to separate into various fuels and components with different boiling points during the refining process. (petroleum or petrochemicals)
        + Produces petcoke, carbon dioxide.
        + Proven oil reserves are being used up, so higher prices and more technology are utilizing previously unavailable oil deposits.
      * Crude Oil Economy (pg. 393)
        + Most of the crude oil supply is controlled by OPEC
        + Algeria, Angola, Ecuador, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela.
        + Proven Oil Reserves

Venezuela, Saudi Arabia, Canada

* + - * + Oil Production

Saudi Arabia, Russia, U.S.A

* + - * + Oil Consumption

United States, China, Japan

* + - Natural Gas
      * Mixture of gases, primarily methane followed by propane, butane, and hydrogen sulfide, that is found in deposits above crude oil.
      * Mined via fracking and liquefied under high pressure. (reduces net energy and increases cost)
      * Natural Gas Economy (pg. 395)
        + Proven natural gas reserves

Iran, Russia, Qatar

* + - * + Natural gas production

United States, Russia, China

* + - * Natural gas consumption
        + United States, Russia, China
    - Coal
      * Most abundant fossil fuel, formed from the remains of land plants exposed to high heat and pressure.
      * Dirtiest of all fossil fuels that degrades land and pollutes water and air. (39% of all CO2 emissions, largest emitter of greenhouse gases)
      * Medium to High net energy and low cost
      * Coal Economy (pg. 399)
        + Proven coal reserves

United States, Russia, China

* + - * + Coal Production

China, United States, Indonesia

* + - * + Coal consumption

China, United States, India

* + Nuclear Power
    - Nuclear Fission
      * A neutron is used to split a large nucleus into two or more smaller nuclei releasing neutrons causing chain reactions that release enormous amounts of energy.
      * Environmental Challenges
        + Large amounts of CO2 are emitted while building nuclear power plants.
        + Short life spans (licensed to operate 40 years)
        + Uranium fuel in reactors are radioactive
        + 10 years after being removed, a spent reactor can emit enough radiation to kill a person 39 inches away in less than 3 minutes.
        + Risk of Accidents
        + Future of Nuclear Energy is Uncertain
      * Nuclear Fusion could be a solution
        + Nuclei of two isotopes of a light element, such as hydrogen, are forced together at high temperatures to form a heavier nucleus and releasing large amounts of energy.
        + Could be a limitless source of energy
        + No risk of meltdowns
        + No radioactive materials
        + Little risk of nuclear weapons
        + Could destroy toxic waste
        + Supply electricity for desalination plants
        + Produce hydrogen fuel
  + **Renewable Energy Sources**
    - Why is energy efficiency and important energy resource?
      * Energy Efficiency
        + Measure of how much useful work we can get from each unit of energy we use.
        + No energy using device can operate at 100% efficiency. Roughly 84% of all commercial energy in the United States is wasted.
        + Breakdown of U.S. Commercial Energy

87% of energy input is fossil fuels, 8% is nuclear, and 5% is renewable.

43% of energy output is energy waste, 41% is unavoidable energy loss, 7% is in the form of petrochemicals, and 9% is in useful energy.

* + - * Improving Energy Efficiency
        + Cogeneration

Produce two useful forms of energy from the same fuel source.

Denmark generates 53% of their electricity using this method. (U.S. only generates 12%)

* + - * + Fuel Economy

Government goals are to increase vehicles to get 54.5 mpg by 2025.

Gasoline has a lot of hidden costs ($12.00 per gallon)

Gas Guzzler Tax: applied to sale of new vehicles that don’t get at least 22.5 mpg.

* + - * + Green Architecture

Focuses on building design that is energy efficient, resource efficient, and cost efficient.

* Why isn’t renewable energy use in the United States expanding more rapidly?
  + People tend to think that solar and wind energy are too diffuse, too intermittent and unreliable, and too expensive.
  + Lack of government support. (Tax breaks and subsidies much lower than fossil fuels)
  + Prices for nonrenewable energy resources don’t include most of the harmful environmental and human health costs of producing and using them.
  + Takes about 50-60 years to make the transition from one dominant fuel to another.
* Solar Energy
  + Passive and Active Solar Heating Systems (Passive absorb sunlight directly, while active pumps a heat absorbing fluid through collectors)
  + Advantages
    - Medium net energy, low emissions of CO2, Low land disturbance, and moderate cost.
  + Disadvantages
    - Access to sun 60% of time, blockage of sunlight by trees, high installation and maintenance costs, backup systems needed.
  + Solar Cells
    - Photovoltaic cells contain very thin transparent wafers of silicon or silicon with trace amounts of metals. Produce electricity when sunlight strikes them.
    - Advantages
      * Medium net energy, little to no emissions of CO2, ease of installation, competitive costs for newer models.
    - Disadvantages
      * Need access to sun, need a backup system, high costs and short lifespans (20-25 years) for older systems, can disrupt desert ecosystems.
* Hydropower
  + Utilizes the kinetic energy of flowing or falling water to produce energy. (Many utilize dams with turbines and generators)
  + Most widely used and least expensive renewable energy source. (16% of world’s energy)
  + Advantages
    - High net energy, large untapped potential,, low cost, low emissions of CO2
  + Disadvantages
    - Large land disturbance and displacement, high methane emission, disrupt downstream aquatic ecosystems and fish migration.
* Wind Power
  + Second fastest growing source of electricity. (3.5% of electricity, led by United States, China, and Germany)
  + Frontier is currently offshore wind farms.
  + Advantages
    - High net energy, wide availability, low electricity cost, little to no direct CO2 emissions, easy to build and expand, provide land owners with $3,000 - $10,000 a year.
  + Disadvantages
    - Need a large electrical grid, need backup systems, considered an eyesore, produce low-level noise, interrupt or kill birds and bats, temporary environmental damage during construction.
* Biomass and Biofuel
  + Organic matter found in plants or plant-related materials that can be converted to biofuels.
  + Ex: wood, wood wastes, charcoal, agricultural wastes such as sugarcane stalks, rice husks, and corncobs.
  + Renewable if harvested sustainably.
    - Two most common biofuels
      * Ethanol (plants) and biodiesel (vegetable oils) (Led by United States and Brazil) \*\*45% of Brazil’s motor vehicles run on ethanol.
  + Biofuels have three advantages: can be grown throughout much of the world, no net increase in CO2 emissions if done sustainably, and easy to store and transport as well as use in motor vehicles.
* Geothermal Energy
  + Utilizes heat stored in soil, underground rocks, and fluids in Earth’s mantle.
  + Used to heat and cool buildings and water to produce electricity.
  + Only practical at sites with high amounts of underground heat (Iceland is the leader, Most of the U.S. sites exist in California, Nevada, Utah, and Hawaii)
  + Cost estimates for heating and cooling a 2,000 square foot house for as little as a dollar a day.
  + One of the most efficient forms of energy with high net energy and low CO2 emissions.
* Hydrogen Fuel
  + Devices that combine hydrogen and oxygen gas to produce electricity and harmless water vapor.
  + Advantages
    - Can be produced from plentiful water, no CO2 emissions, good substitute for oil, high efficiency.
  + Disadvantages
    - Negative net energy, CO2 emissions if produced using carbon compounds, need for subsidies due to high cost and negative net energy, and need for H2 storage with limited H2 gas available.
  + Investigation 18.1: Energy Proposals for the School
* Natural Hazards
  + Severe Weather
    - Includes tornadoes, supercell thunderstorms, and hurricanes.
    - Hurricanes
      * Characterized by swirling high velocity wind, heavy rain, and high storm surges (rise in sea level up to 33 ft) that cause high waves and flooding.
      * Named as hurricanes, typhoons, or cyclones depending on which ocean they form in. (Atlantic, Pacific, or Indian respectively.)
      * Anatomy
        + Circulating masses of clouds and warm, moist air. Zones of low pressure that cause air to rise and condense.
        + Driven by warm ocean water in the tropics. Can grow in size and strength if it encounters additional warm, evaporating water. Dissipates over land or cool water. (Climate change = more hurricanes)
        + Spin counterclockwise in the Northern Hemisphere due to Coriolis Effect.
      * Dry air flows in the center of the storm, compresses, and evaporates any clouds. Known as the eye. The wall of the eye consists of the most severe thunderstorms in the hurricane.
      * Hurricanes develop from tropical disturbances to tropical storms to hurricanes based on wind speed. (74 mph = hurricane)
  + Supercell Thunderstorms
    - Rare, but account for most damage caused by thunderstorm activity. Can generate powerful tornadoes and can last hours.
    - Thunderstorms are known as columns of turbulent, moist air with variable amounts of lightning, thunder, rain, hail, and strong wind. Characterized by a flat-topped anvil shape that points in the direction of travel.
    - Supercells form when a horizontal vortex of spinning air mass becomes vertical.
    - Intense rain and hail form and can lead to brief downpours. Updrafts (upward moving winds) can rotate causing tornadoes.
    - Lightning occurs due to electrical, static charge in the clouds discharging in the air or the ground. Thunder accompanies due to the rapid heating and expansion of air along the lightning.
    - Microbursts are strong, downward moving winds that can flatten trees or structures. (Straight-line winds, not rotating)
  + Tornadoes
    - Violent, rotating funnel shaped columns of air that extend to the ground. If it doesn’t reach the ground we call it a funnel cloud.
    - Most occur in the central/east parts of the country called tornado alley.
    - The intense low pressure inside the funnel is the reason that things are sucked up inside the tornado.
    - Fujita-Pearson Scale
    - F0, F1, F2, F3, F4, F5, F6 (Handout pg. 91 Meteorology Book)
* Volcanoes and Volcanic Activity
  + Vent where magma and other volcanic products erupt onto the surface.
  + Contain a crater. Circular depression near the top of the volcano.
  + Consist of volcanic rocks
  + Types
    - Scoria Cone: cone shaped, tall, with a small crater. Commonly have loose black or red cinders and large volcanic bombs.
    - Shield: Broad, gently curved slopes. Relatively small with a crater or line of craters and fissures.
    - Composite Volcano: Fairly symmetrical mountains with steep slopes and a crater. Very tall.
    - Volcanic Dome: Dome shaped features. Contain solidified lava and are highly fractured.
  + Factors that control Style of Eruption
    - Magma Flow
      * Magma contains dissolved gas due to pressure. (Think pop in a can.)
      * As magma rises, pressure decreases, and bubbles of gas form in the magma.
      * Higher the gas content = quicker expansion of magma = larger eruption.
    - Lava flows
      * Viscosity (Felsic - more viscous - explosive vs Mafic - less viscous - lava flows)
    - Lava fountain (pyroclastic eruption)
    - Volcanic ash/tephra (pyroclastic eruption)
    - Pyroclastic flow
    - Eruption column
  + Caldera
    - Most violent phenomena. Spread volcanic ash over huge areas and erupt more than one thousand cubic kilometers of magma.
    - Calderas are large, basin-shaped volcanic depressions with a low central part surrounded by a wall. (Picture) Ex: Crater Lake
    - Formation
      * Forms in the same moment as the eruption. As the magma chamber empties, the surface subsides down into the empty magma chamber.
    - Caldera Disasters
      * Discuss Yellowstone
  + Areas with highest potential for volcanic hazards
    - Assessing Danger
      * Shape (steep slopes indicate danger)
      * Rock Type (felsic = danger)
      * Age and History
    - Areas of Risk
      * Proximity
      * Valleys (lava flows)
      * Wind Direction
      * Particulars of a Volcano
      * Steepness, Domes, etc.
      * **Formative Assessment: Image of Villages pg. 160**
* Earthquakes and Tsunamis
  + Earthquakes
    - Occurs when energy stored in rocks is suddenly released, typically along a fault causing it to slip.
    - Energy is released via seismic waves and travel along the interior and surface of the Earth.
    - The focus is the paint at which the EQ takes place below the surface, while the epicenter is the point on Earth’s surface directly above the focus.
    - Most occur along plate boundaries. More common in the Eastern Hemisphere.
    - Causes
      * Most commonly caused by faults.
        + Normal faults (hanging wall down)
        + Reverse faults (hanging wall up)
        + Strike slip faults (slide past horizontally)
      * Volcanoes
      * Landslides
      * Meteoroid impacts
      * Explosions
      * Humans and fracking
    - Earthquake (Seismic) Waves
      * Body Waves (waves that travel through the interior of Earth)
        + P Waves: Compresses rock in the same direction it moves. (Fastest wave)
        + S Waves: Shear rock side to side or up and down. Perpendicular to the direction of travel. (Cannot travel via liquids)
      * Surface Waves
        + Horizontal surface wave: surface material moves horizontally or perpendicular to motion of the wave.
        + Vertical surface wave: Moves surface material up and down in an elliptical path.
      * Recording Seismic Waves and Determining Location **(Canton book, pg. 299-301)**
        + Determining Location

Seismometer senses an EQ

Seismograms from 3 centers are collected and analyzed. The P-S intervals are recorded.

The P-S Interval times are placed on a distance-time graph with the distance from each center to the epicenter.

Using the distance calculated, three circles are drawn around each station on a map. Where the three intersect is the epicenter of the EQ.

* + - * + Size

Magnitude is measured via the Richter Scale. (Log scale)

Max height of the S-wave is measured. A line is drawn connecting the distance of the station to the amplitude. Where the three lines intersect indicates the magnitude on the Richter scale.

* + - Tsunamis (Film Possibly)
      * Caused by an EQ beneath the ocean. A plate may build up and when suddenly released, it displaces a large amount of water causing a buildup of a large wave.
      * Tsunamis travel away from the epicenter at speeds of 370-500 mph. (Small in deep water and gets taller closer to shore)
      * Buildup of water can cause water to retreat from shoreline. (Indicator of a Tsunami approaching.)
      * Investigation 12.18: Where did this EQ occur and what damage might be expected?
* Human Impacts
  + What are some key factors of sustainability?
    - Environmental science is a study of how humans interact with the environment.
    - 3 goals of E.S.
      * Learn how life on Earth has survived and thrived.
      * Understand how humans interact with the environment.
      * Find ways to deal with environmental problems and live more sustainably.
    - Factors of Sustainability (capacity of Earth’s natural systems that support life to maintain stability or to adapt to changing environmental conditions indefinitely) are broken down into 3 broad categories:
      * Scientific Factors of Sustainability
        + Solar Energy, Biodiversity, Nutrient cycling
      * Social Factors of Sustainability
        + Economics, Politics, and Ethics
      * Natural Capital
        + Natural resources and ecosystem services that keep humans and other species alive and that support human economies.
        + Ecosystem Services

Nutrient cycling, Purification of air and water, Renewal of topsoil, Pollination, Pest Control

* + - * + Activities that Degrade Natural Capital

Overuse of renewable resources, Pollution and waste, Forest loss, Groundwater contamination (aquifers), Invasive species, over hunting/fishing, overgrazing

* + - Pollution: Where does it come from?
      * Pollution is contamination of the environment via chemical, noise, thermal energy, etc. at levels that are harmful to the health, survival, or activities or organisms.
      * Sources:
        + Point sources: any identifiable source of pollution.
        + Nonpoint source: pollutants that come from many diffuse sources that are hard to pinpoint.
        + Regulated by cleanup or prevention….which is the better route??
    - Ecological Footprint \*Calculate your own activity! School!
      * Amount of land and water needed to supply an individual or population with renewable resources and to absorb and recycle the wastes and pollution such resource use produces. (Estimate)
      * If the footprint is larger than its biological capacity the area has an ecological deficit.
      * Earth’s needs based on our Ecological Footprint as of 2012
        + 2012: 1.5 Earths
        + 2030: 2 Earths
        + 2012 if everyone on Earth had the same ecological footprint as the average American: 5 Earths
* What causes environmental problems and why do they persist?
  + The Human Population and its Growth Rate
    - Exponential growth occurs when a quantity increases at a fixed percentage per unit of time.
      * Starts slow and then grows extremely large. (Think of a sheet of paper and folding)
      * When graphed it resembles a J-curve. As of 2015 the rate of growth was 1.2%.
* Affluence and Unsustainable Resource Use
  + Affluence means a high level of resource consumption.
  + Improvement in quality of life increase environmental degradation, wastes, and pollution.
  + The United States (4.4% of global population) is responsible for about 15% of the global ecological footprint.
  + Affluent can also be positive
    - Widespread and better education about environmental quality.
    - More money for technologies to reduce pollution, waste, and environmental degradation.
* Global Climate Change
  + What are the major air pollution problems?
    - Air pollution is any gaseous or solid material in the atmosphere that occurs in concentrations high enough to harm organisms, ecosystems, or human-made materials or alter climate.
    - Sources
      * Natural
        + Wind-blown dust, solid and gaseous pollutants from wildfires and volcanic eruptions, and volatile organic compounds released by some plants.
    - Human
      * Industry and Transportation.
        + Primary pollutants: chemicals emitted directly into the air at concentrations high enough to cause harm.
        + Secondary pollutants: primary pollutants react with one another and other natural components to form new pollutants.
        + Ozone

Component of smog along with sulfur dioxide and sulfuric acid.

Humans have decreased ozone in the stratosphere (needed to block harmful UV rays) and increased ozone at ground level.

* What are the effects of climate change?
  + Climate Change has accelerated
  + Global warming is a misleading term, climate change is a more accurate term.
    - Change in weather conditions of Earth or a particular area over a period of at least 3 decades. Some locations will warm while some cool.
    - Climate change is not new, however it is currently happening faster than ever before. (most of the recent, sharp rise has taken place since 1975)
  + Factors that cause climate change
    - Large scale volcanic eruptions
    - Changes in solar input
    - Continents moving
    - Impacts by large meteors
    - Slight changes in the planet’s wobbly orbit
    - Global air circulation patterns
    - Changes in the size of large areas of ice
    - Concentrations of greenhouse gases
    - Changes in ocean currents.
  + Climate Change Debate
    - Media makes this misleading.
    - 97% of climate scientists agree climate change is occurring and what is causing it.
    - Debates are mostly political (citizens and politicians)
    - Evidence of Historical Climate Change (Research assignment)
      * Isotopes in rocks and fossils
      * Plankton and isotopes in ocean sediments
      * Tiny bubbles, layers of soot, and other materials trapped in layers of ancient air found in ice cores
      * Pollen from the bottoms of lakes and bogs
      * Tree rings
      * Atmospheric temperature measurements taken since 1861.
  + Climate Change Conclusions (IPCC, U.S. National Academy of Sciences, NASA, NOAA)
    - Climate change is happening now caused mostly by human activities such as deforestation and burning of fossil fuels and it will get worse.
    - Immediate and sustained action to curb climate change is possible and affordable.
    - Sooner people act to slow climate change, the lower the risks and costs of climate disruption.
  + Evidence of Current Climate Change (Science Focus 16.2 Assignment)
    - Earth’s average global surface temperature rose 1.8 degrees F since 1906.
    - 9 of 10 warmest years on record have occurred in the 2000s with 2015 and 2014 being the highest.
    - Glaciers that have existed for thousands of years are melting.
    - Greenland’s ice sheets are melting faster.
    - Glaciers and permafrost are melting in Alaska and rising sea levels are eating away at coastlines.
    - Disrupts water cycle, increased risk of flooding.
    - Organic matter in permafrost will rot and release large amounts of CO2 and methane into the atmosphere.
    - Floating summer sea ice is shrinking in the Arctic.
    - Threatens survival of species that depend on the ice for migration or food. (walruses, seals, seabirds, and polar bears) \*Netflix Planet Earth episode
    - Alter global air currents
    - Contributes to seal level rise
      * Average sea level has rising at an accelerated rate since 1975.
      * 1.3 to 2 feet by the end of the century. (10x what happened last century)
      * According to NASA, a 3 foot rise would result in degradation of estuaries, wetlands, and coral reefs, disruption of coastal fisheries, saltwater contamination, flooding, erosion of barrier islands, submersion of low-lying islands (Fiji and Maldives)
    - Greenhouse gases have risen sharply.
    - Many species have migrated towards the poles or higher elevations or went extinct.
* The Greenhouse Effect
  + Natural process that plays a major role in determining Earth’s average atmospheric temperature and climate. (Dependent on it to a certain extent)
  + Some of the solar energy absorbed by Earth radiates into the atmosphere as heat. Heat reacts with greenhouse gases and increases KE warming the atmosphere.
  + Four Greenhouse Gases
    - Water vapor, carbon dioxide, methane, and nitrous oxide.
* Impacts of Rapid Warming / Worst Case Scenario (within the century)
  + Floods in low-lying coastal cities
  + Forests being consumed in vast wildfires
  + Grasslands turning into dust bowls
  + Rivers drying up
  + Ecosystems collapsing
  + Extinction of up to 50% of world’s species
  + More intense and longer-lasting heat waves
  + More destructive storms and flooding
  + Larger and more widespread droughts
  + Increased flooding due to heavy and prolonged precipitation (warmer air holds more precipitation)
  + Colder winters due to global air circulation
  + Fewer but stronger hurricanes and typhoons
  + Rapid spread of infectious tropical diseases
  + Decline in food production
* How can people slow climate change?
  + Dealing with the problem is difficult due to:
    - Problem is global
    - Problem is a long-term political issue
    - Current and projected harmful and beneficial impacts of climate change are not spread evenly. (Poorer nations experience more impacts)
    - Proposed solutions are controversial (phasing out fossil fuels, disrupt economies and lifestyles)
    - Projected effects are uncertain
* Two main approaches to dealing with climate change
  + Mitigation
    - Slow down climate change in order to avoid its most harmful effects.
  + Adaptation
    - Recognize that some climate change is unavoidable and find ways to adapt.
* Climate Change tipping points (Avoid any and all)
  + Atmospheric carbon level of 450 ppm (400 pm as of 2015)
  + Melting of all Arctic summer sea ice
  + Collapse and melting of the Greenland ice sheet
  + Collapse and melting of most of the West Antarctic ice sheet
  + Massive release of methane from thawing permafrost and Arctic seafloor
  + Collapse of the Gulf Stream
  + Sever ocean acidification, collapse of phytoplankton
  + Massive loss of coral reefs
  + Severe shrinkage and collapse of Amazon rain forest
  + Facing and Managing Climate Change