EARTH SCIENCE CONTENT FACTS

The following is a list of facts related to the course of Earth Science. A deep foundation of factual knowledge is important; however, students need to understand facts and ideas in the context of the conceptual framework. This list is not intended to provide a comprehensive review for State and National Assessments. Its purpose is to provide a highlight of the factual material covered in Earth Science. This list is not all inclusive, be sure to check Nevada State Standards and your district syllabi.

GEOLOGY

Earth Chemistry

- Minerals have different physical and chemical properties (i.e. hardness, streak, luster, radioactivity…) due to their internal atomic arrangement
- The same substance always has the same density, no matter what the size
- **Igneous Rock** ("fire-formed") formed from the solidification/crystallization of magma or lava, classified by color and texture (grain size)
- Rate of cooling affects texture, mineral composition affects color
    - Coarse texture (large grains) = Intrusive (cooled slowly below surface)
    - Fine texture (small grains) = Extrusive (cooled quickly)
    - Glassy texture (no visible crystals) = Extrusive (cooled very quickly)
- **Metamorphic Rock** – changed by heat and/or pressure through the process of recrystallization
    - Shows banding/foliation and distorted structure
    - Higher density, very resistant rock
- **Sedimentary Rock –** formed from the compaction and cementation of loose particles (sediments) or by crystallization from dissolved minerals
    - Rock type most likely to contain fossils

Geologic History

- The Age of the earth is 4.6×10^9 years old, 4.6 billion years old, 4,600 million years.
- Radioisotope decay (half-life) is constant and unaffected by environmental changes (i.e. mass of substance, temperature, pressure…)
- Uranium-238 dates very old rocks (half-life 4.5 billion years)
- Carbon-14 dates recent organic (once living) remains up to ~50,000 years old (half-life 5,700 years)
- Undisturbed rock layers – the oldest layer is on the bottom (principle of superposition)
- Intrusions and faults are younger than the rock they cut through (principle of cross-cutting relations)
- Unconformity is a buried erosional surface (represents a gap in the rock record)
- Index fossils are good time markers (widely spread, abundant, lived a short time)

Weathering and Soil

- Weathering is the breakdown of rock into sediments
- When a rock is broken into smaller pieces, surface area increases and weathering rate increases
- Chemical weathering occurs mostly in warm, humid climates
- Physical (mechanical) weathering occurs mostly in cold and/or arid climates
- Porosity (% of open space) does not depend on particle size
- Permeability is the ability of fluids to flow through ground material (pores must be connected)
- As particle size increases, permeability also increases
- Capillarity (upward movement of water through the ground, depends on surface area), as particle size decreases, capillarity increases

Erosional/Depositional Systems

- Erosion is the transporting of weathered sediments
- Gravity is the main **force** behind all erosion
- Running water (streams, rivers) is the #1 agent of erosion
- Stream velocity depends on slope and discharge (amount of water moving though the stream)
- In a meander, velocity is greater (therefore erosion is greater also) on the outside of the curve
- Heavy, round, and dense particles settle out first
- In graded bedding (vertical sorting) the largest sediments are on the bottom.
- Water and Wind create sorted deposits of sediments
- Gravity and Glaciers create unsorted deposits of sediments
- Streams and rivers carve a V-shaped valley, Glaciers carve a U-shaped valley

Mapping/Topography

- The best model for the shape of the Earth is a sphere
- The true shape of the Earth is an Oblate Spheroid (flattened at the poles and bulging at the equator)
- Positions on earth are located using the coordinate system of latitude and longitude
- Latitude is based on the altitude of Polaris (the North Star)
- Latitude lines (parallels) go east/west, just like the Equator, but measure distances north/south
- Longitude is based on the observations of the sun
- Longitude lines (meridians) go north/south, just like the Prime Meridian, but measure distances east/west
- The closer the isolines (i.e. isotherms, isobars, contour lines), the steeper the gradient (slope)

Structural Forces

- Mountains form by uplift, folding and faulting
- Subsidence – the sinking of the crust
- Isostasy: earth's crust in equilibrium (uplift & subsidence)
- Marine fossils (trilobites, seashells…) on mountain tops indicate that the land has been uplifted
- Landscape development is dependant on bedrock structure and climate
- Arid landscape: steep slopes with angular features
- Humid landscape: smooth with rounded slopes and features
- P-waves travel faster than S-waves (and L-waves)
- P-waves travel through solids and liquids
- S-waves travel through solids only (cannot pass through the inferred partially molten outer core)
- The difference in the arrival time of P-waves and S-waves can be used to determine the distance to an earthquake (and the origin time of the earthquake)
- A minimum of three seismograph stations are required to determine the epicenter (location) of the earthquake
- Earth's plates move due to convection currents in the upper-mantle (asthenosphere)
- At Mid-Ocean ridges (spreading center) new crust is created (Divergent Plate Boundary)
- The age of the rock increases as distance from the ridge increases
- At Ocean trenches (subduction zone) old crust is destroyed (Convergent Plate Boundary)
- Continental crust is thick and made of granite
- Ocean crust is thin and made of basalt

ASTRONOMY

- Earth's axis is tilted 23½°, which accounts for the varying amount of daylight and seasons
- The Earth rotates on its axis counterclockwise (from west to east)
- One Earth rotation takes approximately 24 hours (one hour = 15° of rotation)
- Evidence for rotation is the Foucault Pendulum (appears to change direction)
- Most changes in the environment are cyclic (i.e. tides, sunspots, moon phases…)
- The Earth revolves around the sun counterclockwise
- One Earth revolution takes 365.26 days in a slightly elliptical orbit
- All planets orbits are in the shape of an ellipse with the sun at one focus point. (This includes moons, satellites, comets…)
- Earth is **closer** to the sun (perihelion) around **January 3rd or 4th** (winter) and **farther** from the sun (aphelion) around **July 3rd or 4th** (summer)

- The closer a planet is to the sun the greater its orbital velocity
- Summer Solstice occurs on June 21st in the Northern Hemisphere – is the longest day of the year where the vertical rays of the sun are perpendicular to the Tropic of Cancer (23½° North latitude)
- Winter Solstice occurs on December 21st in the Northern Hemisphere – is the shortest day of the year where the vertical rays of the sun are perpendicular to the Tropic of Capricorn (23½° South latitude)
- Equinoxes (equal night and day) occur on September 23rd (Autumnal) and March 21st (Vernal) where the vertical rays from the sun strike the equator, resulting in 12 hours of daylight and 12 hours of darkness everywhere on earth

Earth/Moon Relations

- Half (½) of the Moon's surface is always lit by the sun
- The rate of rotation and rate of revolution are the same for the Moon (which is the reason why we always see the same side!)
- The moon has phases due to the changing position of the moon as it revolves around Earth
- The moon's phases take 29½ days to complete the cycle (about 1 month)
- The moon phases are: (waxing) crescent-quarter-gibbous-full (waning) gibbous-quarter-crescent-new

Sun/Solar System

- Our solar system consists of the sun, nine planets and their moons (satellites), comets, and anything that orbits the sun (the sun's gravity provides the force to hold the solar system together)
- Our solar system is located on one of the outer arms of our Milky Way Galaxy
- Geocentric model – Earth-centered model for the solar system, Ptolemy
- Heliocentric model – Sun-centered model for the solar system, Copernicus
- The sun is massive, containing ~98% of the mass of the solar system and composed mostly of hydrogen with about 10% helium and other trace elements
- The nuclear reaction in the sun's core changes hydrogen to helium and releases tremendous amounts of electromagnetic energy (i.e. light, heat, x-ray…)
- The universe began with a big explosion - "The Big Bang"

METEOROLOGY

Energy Transfer

- A good absorber of electromagnetic energy (EM) is also a good radiator of EM energy
- Dark-colored objects absorb, Light-colored objects reflect EM energy
- Rough surfaces absorb, smooth surfaces reflect EM energy

- Black and rough surfaces are the best absorbers and radiators of EM energy
- Earth absorbs short waves (visible light) and radiates long waves (infrared energy)
- Temperature is a measure of the average kinetic energy of the molecules in a substance
- Energy moves from the source (higher temperature) to the sink (lower temperature)
- Conduction: energy transfer through molecular collisions (solids in contact)
- Convection: energy transfer in fluids through differences in density (circulating currents of gasses and liquids occurring in the atmosphere and asthenosphere)
- Radiation: energy transfer through space (how light energy travels here from the sun and other stars)
- There is **NO** temperature change during a phase change
    - Condensation = phase change from gas to liquid – remove heat energy
    - Freezing = phase change from liquid to solid - remove heat energy
    - Boiling (vaporization) = phase change from liquid to gas – add heat energy
- Water is densest at 4°C, when it is a liquid
- Water expands when it freezes

Weather

- As pressure increases, density increases
- As temperature increases, density decreases
- As altitude increases, air pressure decreases
- As humidity (moisture content of the air) increases, air pressure decreases
- Weather moves from west to east (northeast trend) in the United States
- The dew point is the point at which water vapor condenses
- The closer the dew point temperature gets to the air temperature, the greater the chance for precipitation
- When the dew point temperature equals the air temperature, relative humidity equals 100%
- Precipitation occurs when: warm, moist air rises, cools adiabatically (due to expansion), reaches the dew point temperature, condensation occurs (on condensation nuclei), the droplets collect in masses (cloud formation) and when the drops are large enough, precipitation results
- Air cools adiabatically as it rises due to expansion from the higher atmospheric pressure at low elevations to the lower atmospheric pressures at higher elevations
- Air warms adiabatically as it sinks due to compression by the heavier atmospheric pressure at lower elevations
- Low Pressure = lousy, cloudy (increased cloud development), humid weather, rising air currents, counterclockwise and convergent circulation

- High Pressure = happy, little to no clouds, dry conditions, sinking air currents, clockwise and divergent circulation
- In general, highs are cool and dry; lows are warm and wet
- Wind is due to air pressure differences (a result of unequal heating of Earth's surface)
- Wind blows from high pressure to low pressure
- Wind is named by the direction that it comes from
- Air masses are characterized by their **temperature** and **moisture** characteristics
- Fronts are boundaries between air masses

Climate

- Increase in latitude and altitude have the same affect on climate
- As altitude/elevation increases, air temperature decreases
- Large bodies of water moderate coastal climates (warmer winters, cooler summers)
- The tilt of the earth's axis (23½°) causes Earth's seasons by varying the intensity of solar energy (insolation)
- Vertical rays (overhead sun) can only occur between 23½° N and 23½° S latitudes
- Mountains force air up the windward (cool/moist) side and down the leeward (warm/dry) side (known as the Orographic Effect)
- Carbon Dioxide (CO_2), methane (CH_4), and water vapor are good absorbers of infrared energy (contributing to the Greenhouse Effect)
- Hottest time of any 24-hour period is usually 1-2 hours after noon (maximum insolation), known as the "daily temperature lag"
- Hottest days of the year are usually **1-month after** the day of maximum insolation (which is the summer solstice - June 21st in the Northern hemisphere), known as the "seasonal temperature lag"