

CHESAPEAKE PUBLIC SCHOOLS: EARTH SCIENCE REVIEW

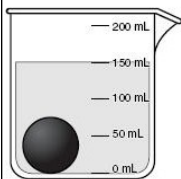
Created by MONICA AGUDELO—GRASSFIELD HIGH SCHOOL

ES 1a: Calculate Density

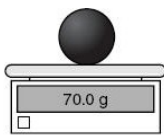
Use the triangle at right (which shows the mathematical relationship between density, mass, and volume) to answer the following:

- mass = density X volume

1. density = _____
2. volume = _____



Sphere in 100 mL of water



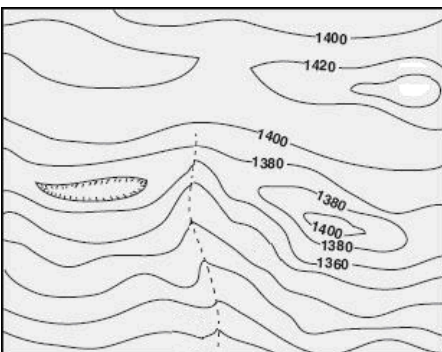
Sphere on balance

3. What is the volume of a mineral measuring 508g and a density of 2.76g/cm³?
4. What is the density of the sphere pictured at left?

****The volume of an irregular solid can be measured using the displacement of water method. The beaker (above) contains 100 mL of water, but the surface reaches 150 mL. What must be the volume of the sphere?**

ES 1b: Technology

- Recall that GPS stands for GLOBAL POSITIONING SYSTEM
- GPS locates points on earth using satellite technology. A GPS unit on Earth's surface must have access to at least 3 satellites orbiting Earth to find a location.
- GPS signals can be blocked by buildings, trees, underground locations, and other objects that could block the signal to space.

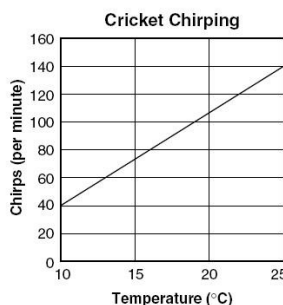


ES 1cd: Diagrams, Maps, Graphs, Exp. Design

- Recall that a topographic map is a map that shows elevation data using contour lines.
- Contour lines are lines that connect points of equal elevation.
- The contour interval is the difference in elevation value between 2 side-by-side contours.

- V-shaped distortions in the contour lines usually indicate a river (see dotted line in sample map above). The V "points" upstream.

1. What is the contour interval of the topographic map shown?
2. Assuming up is north, in which direction is the river flowing?
3. How many chirps per minute will occur at 20°C?
4. At what temperature will there be 75 chirps?
5. From the chart, what is the independent variable?
6. What is the dependent variable?

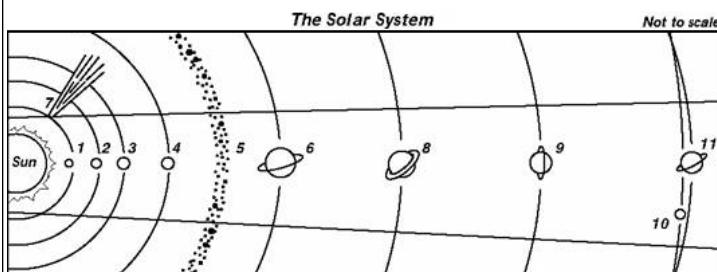


- Independent variable (what is being tested) is under the experimenter's control.
- Dependent variable is the measurable resulting change.
- Constant variables are those variables that are not changed to preserve the independent-dependent variable relationship.

ES 1e: Nature of Science

- Hypotheses are tentative explanations that account for a set of facts.
- Experiments are designed to test hypotheses.
- Theories offer explanations based on **repeated** experiments but may change as new data becomes available.
- Scientific Laws identify repeated patterns or relationships in nature that are generally accepted as true.

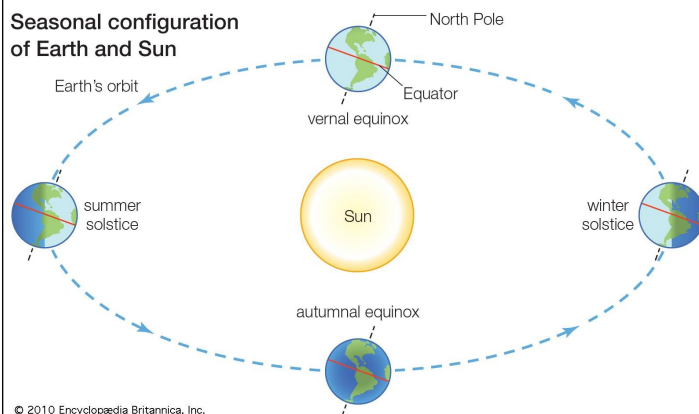
ES 4a: Position of the Earth in the Solar System



- Recall the positions of the objects within the solar system are as follows: SUN, MERCURY (1), VENUS (2), EARTH (3), MARS (4) ASTEROID BELT (5), JUPITER (6), SATURN (8), URANUS (9), NEPTUNE (11), PLUTO (10)
- Comets (7) are icy/rocky objects revolving around the Sun in highly elliptical orbits. Comets' tails always point AWAY from the sun.
- The asteroid belt (5) is a collection of rock bodies that orbit in-between Mars and Jupiter.
- Distances within the Solar system is measured with the Astronomical Unit (AU). 1 AU is equal to the distance between Earth & Sun.

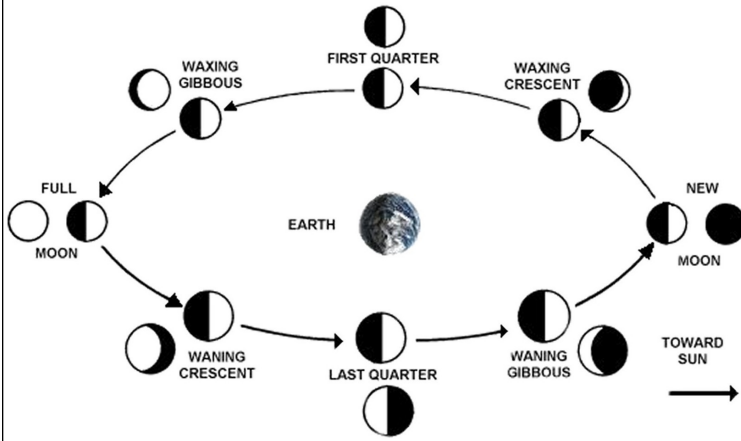
ES 4b: Sun-Earth-Moon relationships

Seasonal configuration of Earth and Sun

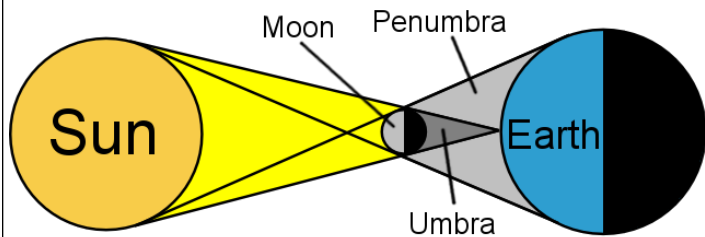


- The Earth revolves (orbits) counterclockwise around the sun in an elliptical orbit.
- The Earth's axis is tilted 23.5°. As a result, the north pole is always pointing towards the star Polaris (The North Star).
- As a result of Earth's tilted axis, the northern and southern hemispheres receive varying amounts of sunlight throughout the year.
- The 4 Seasons are caused by the angle of the rays hitting Earth and the total amount (hours) of sun received at each hemisphere. *Note: seasons has nothing to do with the distance between Earth & Sun!*
- Equinoxes occur when direct sunlight hits the Equator and mark the first day of Spring (vernal equinox) and Fall (autumnal equinox).

ES 4b: Sun-Earth-Moon relationships



- The moon orbits counterclockwise around the earth in an elliptical orbit.
- The moon is visible because of the reflection of the sun's light.
- As the moon orbits the Earth, we see differing amounts of the reflected light here on Earth. This causes an *apparent* change in the Moon's shape called the Lunar phases.
- When the moon *appears* to increase in size, it is in the waxing phases
- When the moon *appears* to decrease in size, it is in the waning phases
- An eclipse occurs when an object passes into another object's shadow. A lunar eclipse happens when the moon is covered by Earth's shadow and a solar eclipse is when the Earth passes into the moon's shadow.

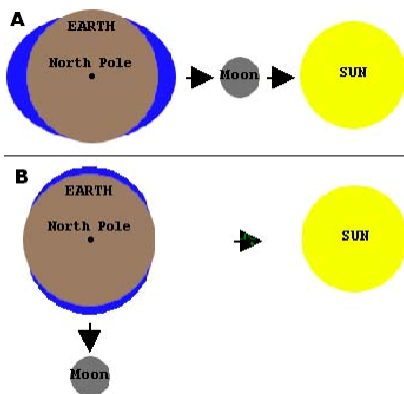


1. What type of eclipse is shown above?

- The tides are the daily, periodic rise and fall of water level cause by the gravitational pull of the moon and sun.

2. Identify the two types of tides pictured below:

- A spring tide occurs when the Earth, Sun, & Moon are aligned in a straight line. Spring tides occur during New and Full moon phases and mark the highest High and lowest Low tides.
- A neap tide occurs when the Earth, Sun, & Moon are at right angles. Neap tides occur during the Quarter Moon phases and mark the lowest High & highest low tides.

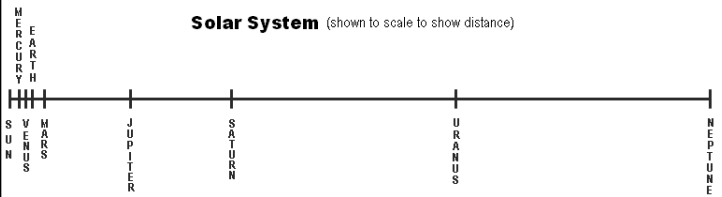


- The Solar System is located within a spiral galaxy called the Milky Way Galaxy.



ES 4c: Characteristics of the Solar System

- Goldilocks Principle: The Earth is neither too close nor too far from the sun. As a result, water naturally occurs on its surface as a solid, liquid, and a gas.
- Venus has a CO₂ rich atmosphere that causes an overactive Greenhouse effect and the hottest temperatures in the solar system.
- The sun is a star that produces heat and light energy in its core through the process of FUSION.



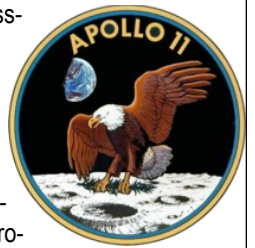
- The standard fusion process converts Hydrogen into Helium.
 $H + H \rightarrow He + \text{Energy}$
- The four planets closest to the sun (Mercury, Venus, Earth, Mars) are referred to as the Inner or Terrestrial Planets.

INNER PLANETS	GAS GIANTS
<ul style="list-style-type: none"> • Small radii • Rocky surfaces • Short orbital period 	<ul style="list-style-type: none"> • Large radii (huge) • Gaseous • Many satellites

- The four planets furthest from the sun (Jupiter, Saturn, Uranus, Neptune) are referred to as the Gas Giants or the Jovian Planets.
- Pluto is a dwarf planet with a tilted orbit (to the plane of other planetary orbits)
- Meteoroids are rocky/metallic objects that orbit the sun and *could* enter the Earth's atmosphere
- Meteors are rocky/metallic objects that have entered the Earth's atmosphere and burn up due to frictional heat with Earth's gases. They are commonly called "shooting stars"
- Meteorites are rocky/metallic space objects that have impacted the Earth's surface. They can create craters at Earth's surface.

ES 4d: History of the Space Program

- Apollo 11 is the first manned mission to successfully land on the Moon.
- The Hubble Space Telescope (HST) constantly orbits the Earth in space. As a result, images are not compromised by the Earth's atmosphere.
- The HST has greatly improved our understanding of the universe due to the clear images it provides.
- The six major US manned space programs are (in chronological order): Mercury, Gemini, Apollo, Skylab, Shuttle, & ISS (International Space Station)



ES 5a: Properties of Minerals

- A mineral is a NATURAL, INORGANIC, SOLID, with a CHEMICAL COMPOSITION, and a CRYSTALLINE STRUCTURE.
- All minerals are rocks but not all rocks are minerals based on the definition stated above. Which of the following are not minerals?

Coal	Pearl	Seashell	Salt	Diamond	Glass	Soil
Quartz	Carbonic Acid	Feldspar	Limestone	Chalk		

ES 5a: Properties of Minerals

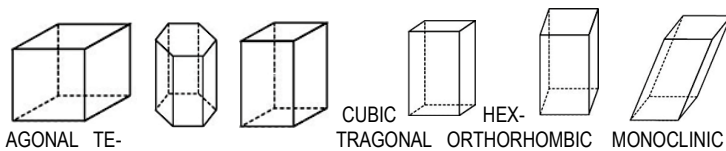
- Minerals can be identified through the observation of various physical properties.
- COLOR:** The actual color of the mineral is the least reliable property in identifying an unknown mineral because color can vary due to impurities in the chemical composition.
- STREAK:** the mineral in its powdered form. Is found when a mineral is scraped against an unglazed ceramic tile.
- HARDNESS:** the mineral's resistance to being scratched. Minerals are ranked on a scale developed by Friedrich Mohs from softest (1 = talc) to hardest (10 = diamond).
- THE WAY THE MINERAL BREAKS:** Minerals can break in 2 ways. **Fracture:** mineral breaks unevenly due to a strong crystal structure & **Cleavage:** mineral breaks along straight planes due to weaknesses in crystal structure.
- LUSTER:** describes the way light shines off the surface. Can be metallic or non-metallic
- Minerals can be divided into groups based on composition.



Mohs Hardness Scale

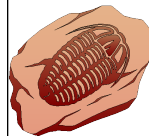
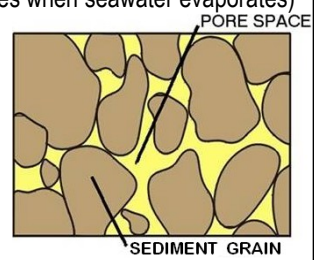
Scale Number	Mineral
1	Talc
2	Gypsum
3	Calcite
4	Fluorite
5	Apatite
6	Orthoclase
7	Quartz
8	Topaz
9	Corundum
10	Diamond

- Silicates** are the most common. Silicate minerals have Silicon (Si) and Oxygen (O) in their chemical composition.
- Carbonates have Carbon (C) and Oxygen (O) (carbonate ion = CO₃)
- Sulfides have Sulfur (S)
- Minerals have crystal structure (the way the atoms are arranged) which determines its hardness, how it breaks, and its crystal shape.
- There are 6 major crystal structure systems:



ES 6b: Sedimentary rocks

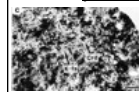
- Sedimentary rocks form from rock fragments (clastic sediments) and/or organic matter bound together by a natural cement.
- Sedimentary rocks can also form by the process of chemical precipitation (ex.: Halite-NaCl, crystallizes when seawater evaporates)
- Weathering:** breaking rocks
- Erosion:** moving rock material
- Sedimentary rocks are usually highly permeable due to pore spaces—the gaps between individual sediments.
- Sedimentary usually form in large, flat, horizontal beds. (stratification)
- Sandstone is a common sedimentary rock and is composed of sand sized clastic sediment grains.
- Shale is a common sedimentary rock and is composed of mud/clay sized grains. Shale has very small pore spaces & is usually impermeable (does not let water pass through)



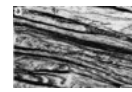
- Limestone is a common sedimentary rock and is composed of organic calcite (CaCO₃). It forms in shallow, ocean environments.
- ~99% of all fossils are found in sedimentary rock.

ES 6c: Metamorphic Rock

- Metamorphic rocks form when ANY ROCK is exposed to extreme heat and pressure.

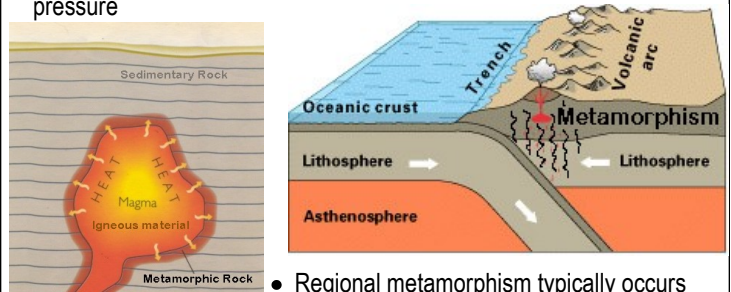


The picture at left shows an intrusive igneous rock.



The picture at left shows a foliated metamorphic rock

- When a rock undergoes metamorphism, the texture changes. **Foliation** occurs when minerals align in parallel bands due to extreme pressure



- Regional metamorphism** typically occurs when two plates crash into each other and apply extreme pressure to the rocks along the convergent boundary. (see above, right)
- Contact Metamorphism** occurs when an igneous intrusion causes surrounding rocks to re-crystallize due to extreme heat from the magma.

ES 5b: Uses of Minerals

- Minerals with complex crystal structures tend to have high values on the hardness scale. Very hard minerals are often used in jewelry as gemstones (ex. Diamond, Topaz, Rubies & Sapphires [corundum])
- Quartz rich sand is used to make glass
- Feldspar minerals easily weather to produce clays that can be used in ceramics and pottery.
- Minerals collected from seawater (salt, magnesium) are used in medicines.

IGNEOUS

INTRUSIVE	EXTRUSIVE
cools inside earth	cools outside earth
Cools Slowly	Cools Quickly
Large crystals	small crystals
ex. Granite	ex. Basalt



Frothy

glassy
(Extrusive)

fine-grain

coarse
(intrusive)

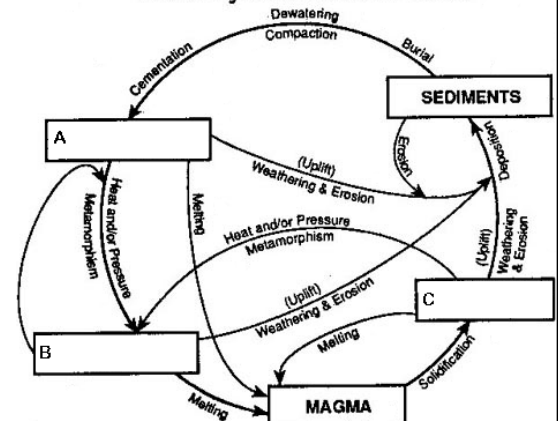
ES 6a: Igneous Rocks

- Igneous rocks form when melted rock cools and crystallizes.
- The speed (rate) of cooling determines the crystal size. Fast = small (or no) crystals. Slow = big crystals
- Magma can cool (slowly) below Earth's surface to form Intrusive rocks.
- Lava can cool (quickly) at Earth's surface to form extrusive rocks.
- Observe igneous textures at left.

ES 6abc: Rock Cycle

Rock Cycle in Earth's Crust

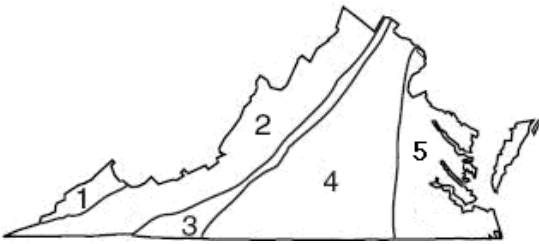
- The primary difference between the 3 major rock types is the **way the rock forms**.
- Complete the rock cycle diagram at right with the appropriate rock type.



ES 7ab: Non-renewable & Renewable Resources

- Renewable Energy resources can be replaced by nature to the rate at which they are used. Examples = wind, sunlight, running water, & vegetation.
- Renewable energies reduce pollution, however, the technologies that use them are expensive and the energy source can be inconsistent in supply (clouds cover sunlight, wind may not blow, etc.)
- Non-Renewable Energy resources are renewed very slowly or not at all. Examples = fossil fuels (coal, oil, gas), & minerals
- Burning fossil fuels causes air/water pollution but the resources are relatively cheap and easy to use.

ES 7c & 8a: Virginia Geology



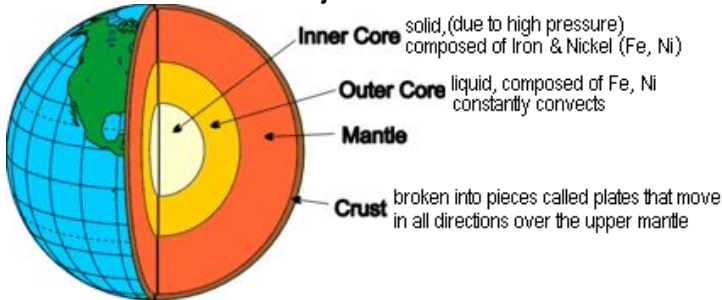
- Virginia has many natural resources including: coal, gravel, and limestone.
- Identify the 5 regions of Virginia

1. (contains coal)
2. (limestone rich Karst geology)
3. (highest elevation in Virginia)
4. (metamorphic)
5. (youngest rocks in VA)

ES 7de: Environmental Awareness

- Acid rain forms when certain gases (usually from burning fossil fuels) absorb into water in the atmosphere.
- The methods by which people remove mineral/rock resources from the earth (surface & underground mining) can *accelerate* rates of erosion and can negatively impact the surrounding environment.

ES 8bc: Major Earth Processes



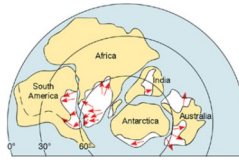
- Plate Tectonic Theory explains why and how the earth's crust moves.
- The earth's lithosphere (~crust) is broken into pieces called plates that move on top of the convecting upper mantle.

EVIDENCE FOR PLATE TECTONICS

Locations Yielding Mesosaurus Fossils



1. Shape of Continents
2. Identical fossils & rock formations along opposing shorelines
3. Glacier Tracks

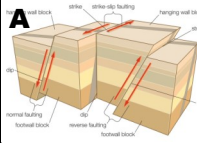


Complete the chart at right with the appropriate terms and arrows

PLATE BOUNDARY	MOVEMENT	Associated Features
Convergent		Mountains, Volcanic Island arcs, trenches, folds, reverse faults, subduction
	↔	Mid-Ocean Ridges, rift zones, normal faults
Transform	↔	Strike-slip faults

ES 8bc: Major Earth Processes

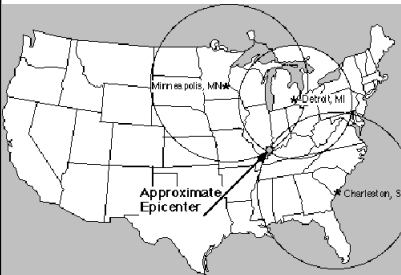
- **Tectonic Activity** is events that occur as a result of the moving crust. The following processes are examples of tectonic activity:
 - **Folding** occurs when rocks are compressed into wavy patterns
 - **Faulting** occurs when the crust sustains a major crack/break



Which picture shows a fault and which shows a fold?



- **Volcanism** occurs when magma erupts through Earth's surface
- **Earthquakes** occur when seismic waves pass through earth's crust as a result of major breaks (faults) in the Earth's crust.
- There are 2 basic types of seismic waves: P (primary) waves & S (secondary) waves. P waves travel faster than S waves.

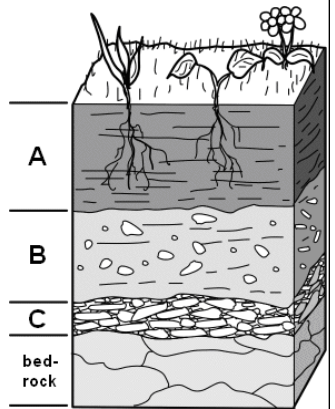


- Seismographs are devices that detect seismic waves in the Earth's crust. One seismograph will identify the distance to the epicenter of the earthquake.
- At least 3 seismographs are necessary to find the epicenter of an earthquake.

- **Subduction** occurs during convergence when a plate sinks below another plate. Plates subduct because: composition (oceanic crust), age (old), or temperature (cold) cause it to be more dense.

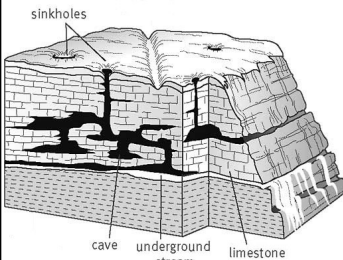
ES 9a: Soil

- Soil is a mixture of rock fragments, clay, and organic material.
- Soil forms as a result of weathering and biological processes.
- Very well developed soil occurs in layers called **horizons**:
 - * A horizon is closest to the surface of the earth and is composed of organic material (humus)
 - * B horizon is beneath the A horizon and is composed of clay particles.
 - * C horizon is beneath the B and is composed of rock particles.
- Soil is a non-renewable resource.



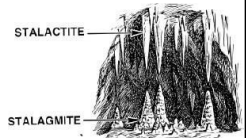
ES 9b: Karst Topography

- Karst topography is developed in areas underlain by carbonate (most commonly LIMESTONE) rocks.
- Areas with Karst includes features like caverns, caves, & sinkholes.



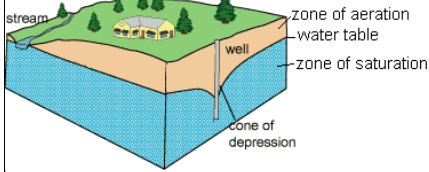
- Caverns & caves form when slightly acidic groundwater slowly dissolves the carbonate rock.
- As the water flows through the rock, special cave rock features form when mineral rich water drips from the ceiling to the floor.

- Karst topography exists in the Valley & Ridge region of VA where limestone is abundant



ES 9cd: Groundwater

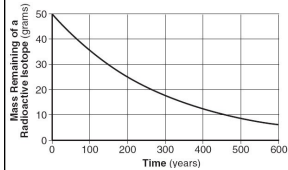
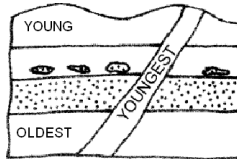
- Water enters the Earth's crust through the process of infiltration.
- As water infiltrates, the water travels through pore spaces.
- As groundwater flows, 2 zones are created. The **zone of aeration** exists where pore spaces are filled with air and the **zone of saturation** is the area where the pore spaces are filled with water. The boundary between these two zones is the **water table**.
- The water table lowers during drought conditions and rises during periods of heavy rain.



- Water can be removed from the ground through wells. As water is removed, the water table surrounding the well becomes distorted in a V shape.

ES 10abcd: Earth History

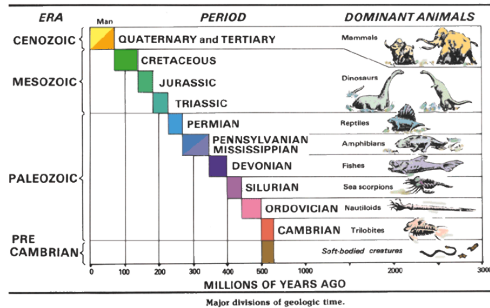
- Fossils are commonly found in _____ rocks.
- Earth is approximately 4.6 billion yrs old
- Relative Age** dating is a technique used to assign an age to rocks/fossils without using a number value (older/younger).
- Law of Superposition** states that layered rocks get older with increasing depth.



- Absolute Age** dating is a technique using the half-life of radioactive isotopes to determine the actual age of rocks/fossils.
- Half-life** is the time it takes for half of the radioactive isotope to decay. It NEVER speeds up or slows down.

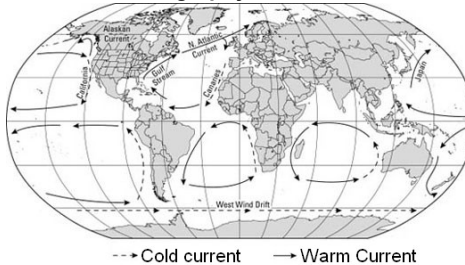
- What is the half-life of the radioactive element shown in the graph?
- How many half-lives will have elapsed when only 6.25% radioactive material remains?

- Fossil evidence indicates that life forms have changed and become more complex over time.
- Earth time has been divided into 3 basic eras: Cenozoic (current), Mesozoic (dinosaurs), & Paleozoic (fish).

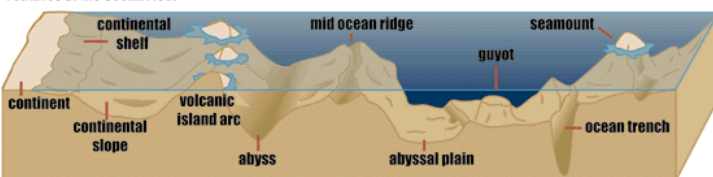


ES 11abcde: Oceanography

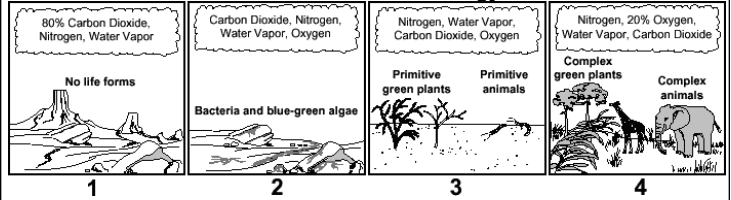
- Waves are generated by atmospheric winds at the ocean's surface.
- Surface currents carry warm water toward the poles & cold water towards the equator.
- Melting polar ice caps causes sea level to rise.
- The Chesapeake Bay is an **estuary** that consists of low salinity water and high biological activity.
- Tectonic features on seafloor = Mid-ocean ridge, seamount, trench



Features of the Ocean Floor



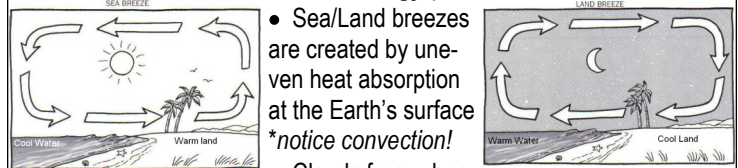
ES 12abcde: Meteorology



The pictures above show the general development of the Earth's atmosphere. Note that the early atmosphere contained mostly Carbon dioxide but today has mostly Nitrogen (78%), Oxygen (21%) and >.1% CO₂

- In the 2nd image above, Oxygen is introduced into the atmosphere by blue-green algae which completes the photosynthesis reaction.
- Once Oxygen was present in Earth's atmosphere, animal life became possible.
- Water Vapor, Methane, & Carbon Dioxide (CO₂) are greenhouse gases. Greenhouse gases effectively absorb infrared heat energy from the Earth's surface, thus making Earth's temps hotter.
- Humans have increased the amount of CO₂ in the atmosphere through burning fossil fuels. Also humans release chemicals into the air (ChloroFluoroCarbons) that can destroy ozone.

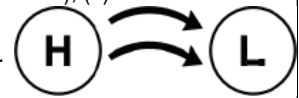
ES 13: Meteorology (Weather)



- Sea/Land breezes are created by uneven heat absorption at the Earth's surface *notice convection!
- Clouds form when

- water evaporates,
- moist air rises higher in the atmosphere,
- air cools to its dew point temperature (as it rises),
- moisture condenses to form liquid cloud droplets.

- Winds form by differences in air pressure. Wind always flows from High to Low pressure.



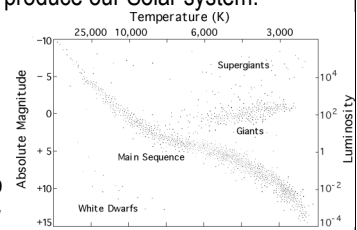
- The Coriolis Effect is caused by the Earth's rotation and deflects the path of winds, planes, etc. It also causes air to circulate counter-clockwise around Low pressure (cyclonic flow)

- As wind rises up a mountain, 2 climatic zones can be created. Clouds (side A) create a rainy climate and sinking air creates a desert climate.



ES 14abcde: Cosmology

- Nebulae = large clouds of gas (Hydrogen) & dust where stars form.
- Solar Nebula Theory** = a nebula within the Milky Way Galaxy condensed about 5 billion years ago to produce our Solar system.
- The Hertzsprung-Russell (HR) Diagram (at right) organizes stars according to magnitude (brightness) and surface temperature (color).
- The **Main Sequence** show ~young stars that range from hot & bright to ~cool & dim. **White Dwarfs** are very hot & dim stars; **Giant** stars are very bright & ~cool stars both are dying.
- Distance in space is commonly measured with the **light year**.
- The Big Bang Theory is the current explanation for the origin of the universe & is supported by red-shift data that shows the universe is steadily expanding.



EARTH SCIENCE REVIEW

SOURCES OF IMAGES/WORKS CITED

- ES 4b:** Seasonal Configuration of Earth & sun <http://www.britannica.com/bps/media-view/112844/1/0/0>
- ES 4b:** Diagram of the Moon's Orbit & phases http://www.paganinstitute.org/PIR/lunar_info.html
- ES 4b:** Diagram of eclipse http://commons.wikimedia.org/wiki/File:Solar_eclipse.png
- ES 4b:** Diagram of tides <http://curious.astro.cornell.edu/question.php?number=143>
- ES 4d:** Apollo 11 mission patch <http://www.nasa.gov>
- ES 5a:** Mineral Streak Plate <http://geology.csupomona.edu/alert/mineral/streak.htm>
- ES 5a:** Mineral crystal systems <http://www4.nau.edu/meteorite/Meteorite/Images/CrystalSystems.png>
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- ES 6b:** Pore Space <http://aquifersandhealth.org/faqs/aquifers/>
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- ES 8bc:** Tectonic Activity <http://www.britannica.com/bps/media-view/1423/1/0/0>
- ES 9cd:** Groundwater Diagram <http://geology.er.usgs.gov/eespteam/brass/aquifers/aquifersintro.htm>
- ES 10abcd:** Superposition/crosscutting diagram <http://www.wesleyan.edu/ctgeology/LISproject/Relative%20ages.htm>
- ES 10abcd:** Earth Timeline <http://www.mbm.gmtech.edu/gmr/gmr-montanageology.asp>
- ES 11abcde:** Seafloor Features <http://www.mos.org/oceans/planet/features.html>

Associated Features	MOVEMENT	PLATE BOUNDARY
Mountains, Volcanic Island arcs, trenches, folds, reverse faults, subduction		Convergent
Mid-Ocean Ridges, rift zones, normal faults		Divergent
Strike-slip faults		Transform

PAGE 5
ES 10 abcd
sedimentary

PAGE 4
ES 7c&8a
1. Appalachian Plateau
2. Valley & Ridge
3. Blue Ridge
4. Piedmont
5. Coastal Plain
ES 8bc
*See chart below
A = Normal Faults
B = Folds

PAGE 3
ES 6abc
A = Sedimentary Rock
B = Metamorphic Rock
C = Igneous Rock

PAGE 2
ES 4b
1. Solar eclipse
2. A = Spring Tide
B = Neap Tide
ES 5a
Coal, Pearl, Seashell, Soil, Lime-
stone, & Chalk are **not** minerals
because they are organic (from
life). Glass is not a mineral be-
cause it has no crystal structure.
Carbonic acid is not a mineral
because it is liquid/not crystalline.

PAGE 1
ES 1a
1. mass/volume
2. Mass/density
3. 508 g/2.76 g/cm³ = 184.1 cm³
4. 70g/50mL = 1.4g/mL
1. Contour Interval = 20
2. South
3. ~108 chirps at 20°C
4. 15°C
5. Temperature
6. Cricket chirp rate