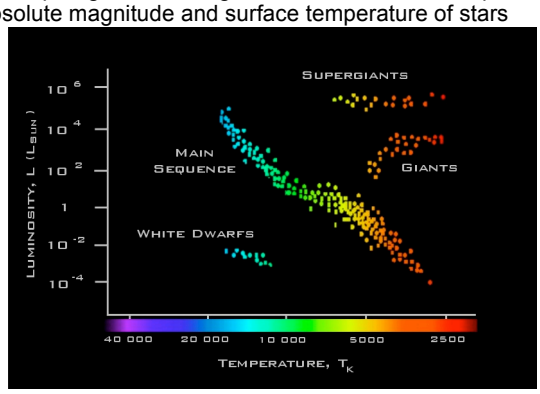
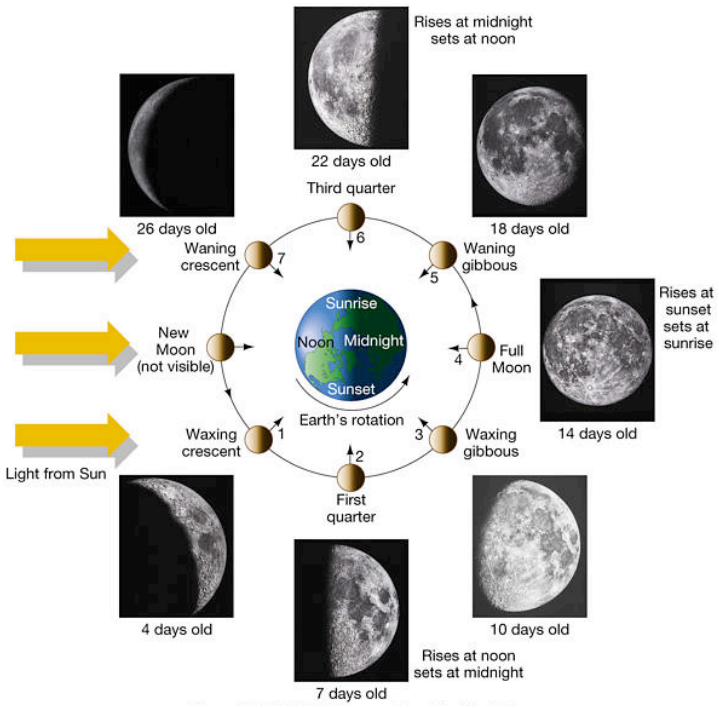
Astronomy SOL Review

Origin and Evolution of the Universe

- universe is vast and very old
  - much of information about our galaxy and universe comes from ground-based observations
- ***Big Bang Theory***: states the universe began in a very hot and dense sphere that expanded and eventually condensed into galaxies; best current model of the origin of the universe
- ***Solar nebular theory***: explains that the planets formed through condensing of the solar nebula; best current idea for the origin of the solar system
- ***stars***: have a finite lifetime and evolve over time; form by condensation of interstellar gas
  - stars form by condensation of interstellar gas
  - Hertzsprung-Russell diagram illustrates relationship between absolute magnitude and surface temperature of stars



  - mass of star controls its evolution, lifetime length, and ultimate fate
- ***galaxies***: collections of billions of stars
  - Basic types: spiral, elliptical, irregular
- ***light year***: distance light travels in one year; most commonly used measurement for distance in astronomy

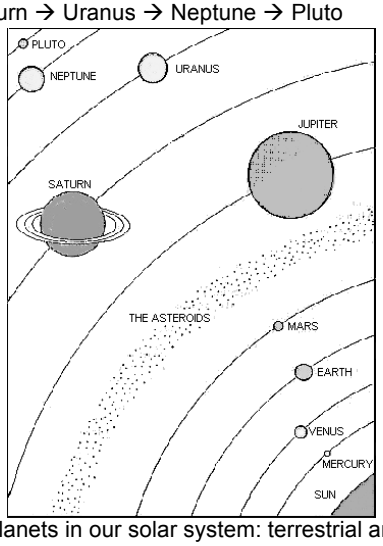


Solar System

- consists of many types of celestial bodies, including sun, nine planets (at this time) and their moons, comets, meteors, and asteroids
- still learning more about solar system through space exploration efforts
  - Apollo 11: first manned landing of the moon
  - Hubble Space telescope has greatly improved our understanding of the universe
- located in the Milky Way galaxy
- ***moons***: natural satellites of planets that vary widely in composition
- ***sun***: star consisting largely of hydrogen gas; energy comes from nuclear fusion of hydrogen to helium
- ***comets***: orbit the sun and consist mostly of frozen gases
- ***asteroids***: rocky or metallic iron objects ranging in size from millimeters to kilometers; source of most meteorites

Planets

- order of planets from sun: Mercury → Venus → Earth → Mars → Jupiter → Saturn → Uranus → Neptune → Pluto



- two types of planets in our solar system: terrestrial and gas giants
- four inner terrestrial planets consist mostly of solid rock
- four of outer planets ("gas giants") consist of thick outer layers of gaseous materials, perhaps with small rocky cores
- fifth outer planet is Pluto: has an unknown composition; appears solid
- ***Earth***: third planet from the sun; located between the sun and the asteroid belt; one natural satellite – the moon
  - Revolves elliptically around the sun (365.25 days = 1 revolution), tilted on its axis – causes seasons (equinoxes and solstices)
  - water's state (ice, liquid, vapor) on Earth depends on Earth's position in solar system
- ***the moon***: revolves around Earth (1 revolution = 24 hours) creating moon phases and eclipses
  - solar eclipses occur when the moon blocks out sunlight from the Earth's surface
  - lunar eclipses occur when Earth blocks sunlight from reaching the moon's surface
- ***tides***: daily, periodic rise and fall of water level caused by the gravitational pull of the sun and the moon

Meteorology SOL Review

The Origins of Earth's Atmosphere

- composition of Earth's atmosphere has changed over geologic time
- early atmosphere contained little oxygen and more carbon dioxide that today's atmosphere
- early photosynthetic life such as cyanobacteria (blue-green algae) contained carbon dioxide and generated oxygen
- after early photosynthetic life generated oxygen, animal life became possible

Other Planets' Atmospheres

- Venus's atmosphere is mostly carbon dioxide and is very dense
- Mars's atmosphere is mostly carbon dioxide and very thin

Earth's Atmosphere Today

- Earth's atmosphere is unique in the solar system in that it contains substantial oxygen (21% oxygen, 78% nitrogen, 1% trace gases)
- human activities have increased the carbon dioxide content of Earth's atmosphere
- man-made chemicals have decreased the ozone concentration in the upper atmosphere
- volcanic activity and meteorite impacts can inject large quantities of dust and gases into the atmosphere
- ability of Earth's atmosphere to absorb and retain heat is affected by the presence of gases like water vapor and carbon dioxide

Weather and Climate

- ***weather***: describes day-to-day changes in atmospheric conditions
  - energy transfer between the Earth's surface and the atmosphere creates the weather
  - convection in the atmosphere is a major cause of weather
  - convection is the major mechanism of energy transfer in the oceans, atmosphere, and the Earth's interior
  - ***tornado***: narrow, violent, funnel-shaped column of spiral winds that extends downward from the cloud base toward Earth
  - ***hurricane***: tropical cyclone (counterclockwise movement of air) characterized by sustained winds of 120 kilometers per hour (75 miles per hour) or greater
- ***climate***: describes the typical weather patterns for a given location over a period of many years
  - four major factors affecting climate: latitude, elevation, proximity to bodies of water, position relative to mountains
  - Earth's major climate zones: polar, temperature, tropical
- both weather and climate are measurable to an extent predictable

	Symbol		Symbol
Rain	●	Fog	≡
Drizzle	●	Thunderstorm	⚡
Shower	▽	Hail	▲
Snow	✳		

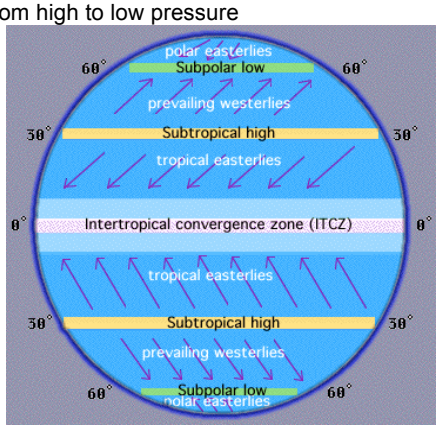
combinations of these can be made, e.g. rain shower, snow shower

The Sun

- Earth's surface is much more efficiently heated by the sun than is the atmosphere
- amount of energy reaching any given point on the Earth's surface is controlled by the angle of sunlight striking the surface and varies with the seasons
- areas near the equator receive more of the sun's energy per unit area than areas nearer the poles

Winds

- *winds* are created by uneven heat distribution at the Earth's surface by the sun and are modified by the Earth's rotation (influenced by the Coriolis effect)
  - ***Coriolis effect*** causes deflections of the atmosphere due to the Earth's rotation
  - flows from high to low pressure



Clouds

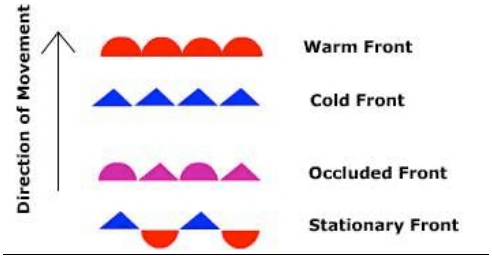
- the conditions for *cloud formation* are air at or below the dew point and the presence of condensation nuclei
- cloud droplets can join together to form ***precipitation***
- ***types***: cirrus: light, thin, feathery (fair weather clouds); cumulus: puffy white clouds; stratus: low gray clouds

Measuring Devices

- thermometer: measures temperature
- barometer: measures atmospheric pressure
- psychrometer: measures relative humidity

Weather Maps

- weather moves from west to east in the US
- symbols for cold fronts, warm fronts, pressure and precipitation should be known
  - high pressure (H): fair weather, circulates clockwise and air sink
  - low pressure (L): bad weather, circulates counterclockwise and air rises
  - air from high pressure always moves to areas of low pressure (*gradients*)
- cold fronts: cold air invades warm air; rain and thunderstorms
- warm fronts: warm air invades cold air; steady rain
- isotherms: lines of equal temperature (like contours)
- isobars: lines of equal pressure (like contours)



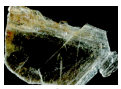
Geology SOL Review

Rocks and Minerals

- rocks and minerals are different
- ***minerals***: naturally occurring inorganic solid substance with a definite composition and structure
  - can be identified by physical properties (hardness, color, luster, streak)
  - important to human wealth and welfare
  - major rock-forming minerals:


quartz


feldspar

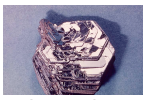

mica


calcite

  - ore minerals:


pyrite


magnetite


hematite


galena


graphite


sulfur

  - most abundant group: silicates (contain the elements silicon and oxygen)
- ***rocks***: most made of one or more minerals
  - can be identified based on mineral content and texture
  - defined by the processes by which they are formed: igneous, sedimentary, metamorphic
  - ***igneous rocks***: form from molten rock that cools and harden either below or on the Earth's surface
    - extrusive igneous rocks: have small or no crystals resulting in fine-grained or glassy textures


pumice


obsidian

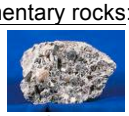

basalt

    - intrusive igneous rocks: have larger crystals and a coarser texture


granite

  - ***sedimentary rocks***: may either form from rock fragments or organic matter bound together or by chemical precipitation
    - clastic sedimentary rocks: made up of fragments of other rocks

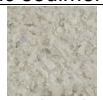

sandstone


conglomerate


shale

    - non-clastic sedimentary rocks:


limestone


rock salt

      - limestone only rock that can be formed both chemically and organically
  - ***metamorphic rocks***: form when any rock is changed by the effects of heat, pressure, or chemical action; can be foliated or unfoliated (nonfoliated)
    - foliated metamorphic rocks: have bands of different minerals


slate


schist


gneiss

    - unfoliated metamorphic rocks: have little or no banding and are relative homogenous


marble

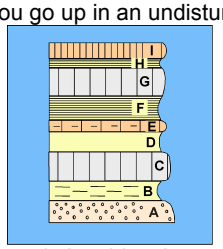

quartzite

Fossils

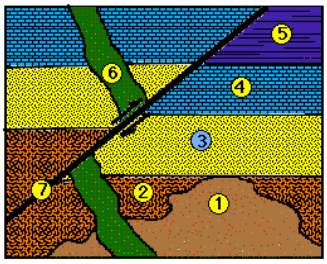
- is the remains, impressions or other evidence preserved in rock of the former existence of life (can be ancient or often extinct)
- some ways fossils can be preserved include molds, casts, and original bone or shell
- nearly all fossils are found in sedimentary rocks
- fossil evidence indicates that life forms have changed and become more complex over geologic time

Dating

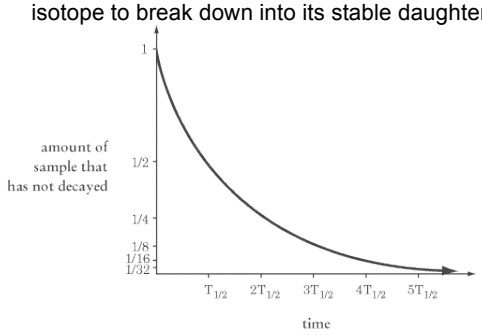
- Earth is very ancient → about 4.6 billion years old
- history of Earth and age of rocks can be investigated and understood by studying rocks and fossils
- ***relative time*** places events in a sequence without assigning any numerical ages
  - fossils, law of superposition, and law of crosscutting relationships are used to determine the relative ages of rocks
    - law of superposition: the oldest layers are on the bottom and get younger as you go up in an undisturbed rock layer



    - law of crosscutting relationships: igneous intrusion (and fault) is younger than the layers it cuts across



- ***absolute time*** places a numerical age on an event
  - radioactive decay is used to determine the absolute age of rocks
    - carbon-14 dating: used for dating organic material up to 50,000 years old
    - uranium: dates the oldest rocks—up to 4.5 billion years
    - half-life: amount of time it takes for 50% of a radioactive parent isotope to break down into its stable daughter product



Geologic Time

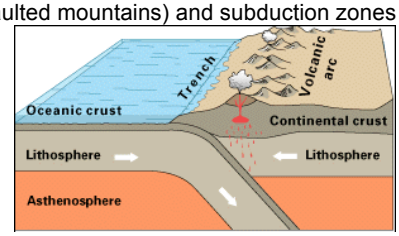
- three major divisions: eras, periods, epochs
  - eras: largest division → ends with extinction events
  - periods: based on index fossils (abundant, worldwide, short-lived)
  - epochs: smallest; based on types of life (only in Cenozoic Era)
- *Precambrian Era*: 90% of all geologic history
  - oxygen not present initially (carbon dioxide instead)
  - blue-green algae (cyanobacteria) produced oxygen leading to creation of ozone and our atmosphere today
- *Paleozoic Era*: Age of Invertebrates; creation of Pangaea
- *Mesozoic Era*: Age of Reptiles; dinosaurs; Pangaea break apart
- *Cenozoic Era*: Age of Mammals; man
- today: we live in Cenozoic Era; Quaternary Period; Recent Epoch

Earth's Composition

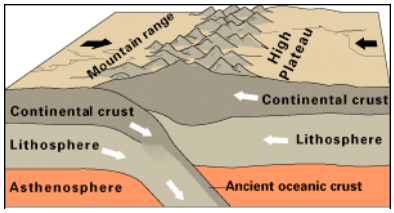
- solid, mostly iron inner core; a liquid, mostly iron outer core; a rocky, plastic mantle; and a rocky, brittle crust
  - core, mantle, and crust are dynamic systems – constantly in motion
  - two types of crust: oceanic and continental → each has very different characteristics
    - ocean (basalt) crust is relatively thin, young, and dense
    - continental crust is relatively thick, old, and less dense
  - Earth's crust major elements: oxygen, silicon, aluminum, and iron

Tectonic Plates

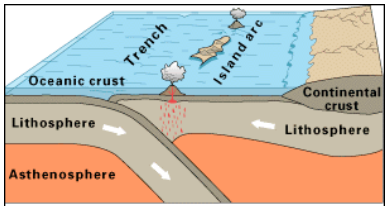
- ***lithosphere***: made of Earth's crust and some of mantle; is divided into plates that are in motion with respect to one another
  - plate motion occurs as a consequence of convection in the Earth's mantle
  - plate tectonics is driven by convection in the Earth's mantle
  - relative plate motions and plate boundaries are convergent (subduction and continental collision), divergent (sea-floor spreading), or transform
  - most geologic activity (earthquakes, volcanoes, mountain building) due to relative motion along plate boundaries
- ***convergent boundaries' features***: collision zones (folded & thrust-faulted mountains) and subduction zones (volcanoes, trenches)



ocean-continent

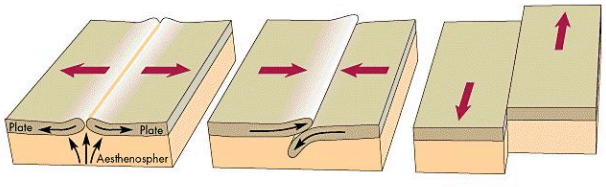


continent-continent



ocean-ocean

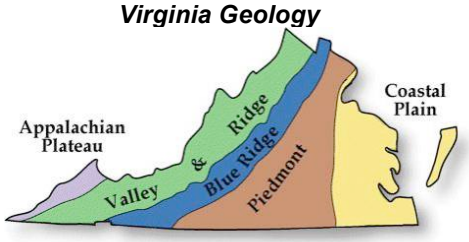
- ***divergent boundaries' features***: mid-ocean ridges, rift valleys, and fissure volcanoes
- ***transform boundaries' features***: strike-slip faults – San Andreas Fault



divergent boundary convergent boundary transform boundary

- earthquake activity is associated with all plate boundaries; result when movement occurs along a fault; 3 seismograph stations needed to locate the *epicenter* of an earthquake
  - faults are breaks or cracks in the crust along which movement has occurred
    - most active faults are located at or near plate boundaries
- folds form when rocks are compressed horizontally and their layers can be deformed into these wave-like forms
  - commonly occurs during continent-continent collisions
- volcanoes openings where magma erupts onto the Earth's surface
  - most volcanic activity associated with subduction, rifting, or sea-floor spreading
  - hot-spot volcanic activity (example: volcanic islands) is exceptional in that it is *not* related to plate boundaries
- continental drift: consequence of plate tectonics

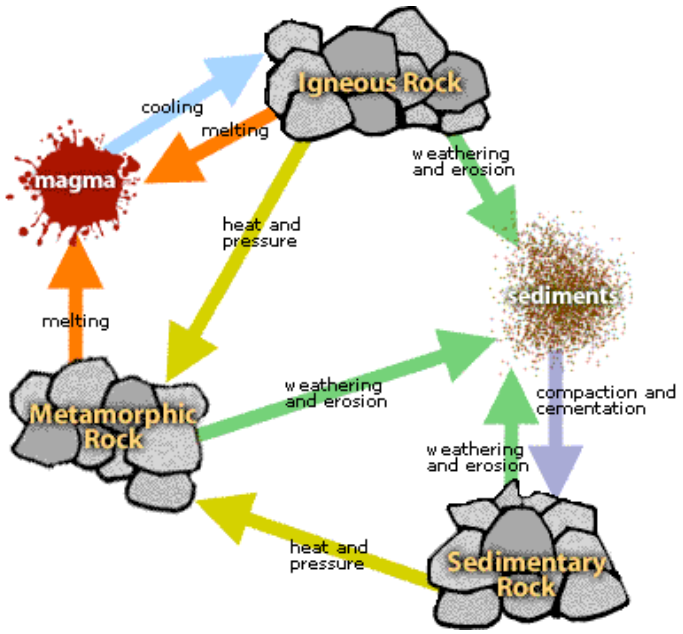
Virginia Geology



- *Coastal Plain*: flat area underlain by young, unconsolidated sediments produced by erosion of the Appalachian Mountains and deposited here
- *Piedmont*: area of rolling hills underlain by mostly ancient igneous and metamorphic rock
  - igneous rocks are the roots of the volcanoes formed during an ancient episode of subduction that occurred before the formation of the Appalachian Mountains
- *Blue Ridge*: high ridge separating the Piedmont from the Valley and Ridge Province
  - billion-year old igneous & metamorphic rocks are the oldest in VA
- *Valley and Ridge Province*: area with long parallel ridges and valleys underlain by ancient folded and faulted sedimentary rocks
  - folding and faulting of the rocks occurred during the collision between Africa and North America
  - collision occurred during the late Paleozoic Era and produced the Appalachian Mountains
- *Appalachian Plateau*: area with rugged, irregular topography and underlain by ancient, flat-lying sedimentary rocks
  - actually a series of plateaus separated by faults
  - most of VA's coal resources found here
- VA fossils are found mainly in the Coastal Plain, Valley and Ridge, and Appalachian Plateau provinces
  - most are of marine organisms → this indicates that large areas of the state were covered periodically with sea water
  - Paleozoic, Mesozoic, and Cenozoic fossils found in VA
- VA major rock and mineral resources: limestone (concrete), coal (energy), gravel and crushed stone (road construction)

Rock Cycle

- process by which all rocks are formed and how basic Earth materials are recycled through time

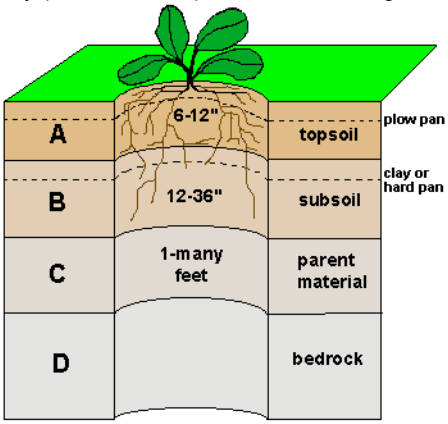


Weathering and Erosion

- weathering, erosion, and deposition are interrelated processes
  - ***weathering***: process by which rocks are broken down chemically and physically by the action of water, air, and organisms
    - mechanical weathering: broken down into pieces without a chemical change (frost/ice wedging)
    - chemical weathering: changes into something chemically different (rusting – oxidation)
  - ***erosion***: process by which Earth materials are transported by moving water, ice, or wind (water is biggest)
    - greatest in high relief areas (steep)
  - ***deposition***: process by which Earth materials carried by wind, water, or ice settle out and are deposited
    - greatest in low relief areas (flat, low, sea level) such as delta, barrier island, beaches and dunes, alluvial fan

Soil

- loose rock fragments and clay derived from weathered rock mixed with organic material (humus)
- soil horizons move from parent rock to more developed soil horizons
- sediment: smallest to largest:
  clay (settles out last) → silt → sand → gravel (settles out first)



A horizon— humus and dark in color (*topsoil*)

B horizon— *lighter in color* and leaching has brought minerals down from topsoil

C horizon— *weathered* parent material

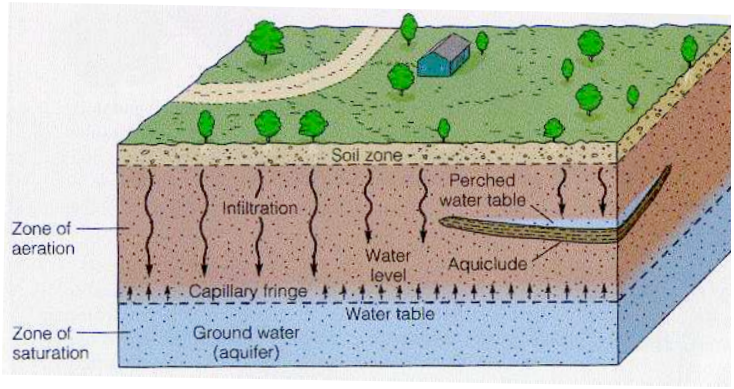
Karst topography

- developed in areas underlain by carbonate rocks including limestone and dolomite
- includes features like caves and sinkholes
- forms when limestone is slowly dissolved away by slightly acidic groundwater
- where limestone is abundant in the Valley and Ridge province of VA, this is common

Freshwater

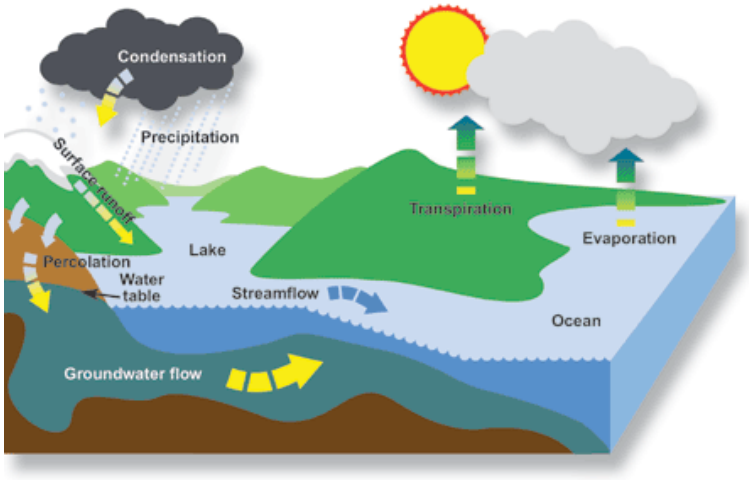
- a substantial amount of water is stored in permeable soil and rock underground
  - permeability: measure of the ability of a rock or sediment to transmit water or other liquids (gravel, sand)
    - water doesn't pass through impermeable materials (clay)
- Earth's water supply is finite
  - geological processes (erosion) and human activities (waste disposal) can pollute water supply
- water is continuously being passed through the hydrologic cycle
- fresh water is necessary for survival and most human activities
- three major regional watershed systems in VA lead to Chesapeake Bay (between MD and VA), NC Sounds, and Gulf of Mexico (borders TX, LA, MS, AL, and FL)

Groundwater



- zone of aeration: soil
- water table: on top of zone of saturation
- aquifer: layer of rock that stores and transports water freely

Hydrologic Cycle



Resources

- resources are limited and are either renewable or non-renewable
  - *renewable resources*: can be replaced by nature at a rate close to the rate at which they are used
    - examples: vegetation, sun light, surface water
  - *non-renewable resources*: are renewed very slowly or not at all
    - examples: coal, oil, minerals
    - fossil fuels are non-renewable and may cause pollution; however they are relatively cheap and easy to use
- there are advantages and disadvantages to using any energy source
- VA has many natural resources
- modern living standards are supported by extensive use of renewable and non-renewable resources
- extraction and use of any resource carries an environmental cost that must be weighed against economic benefit

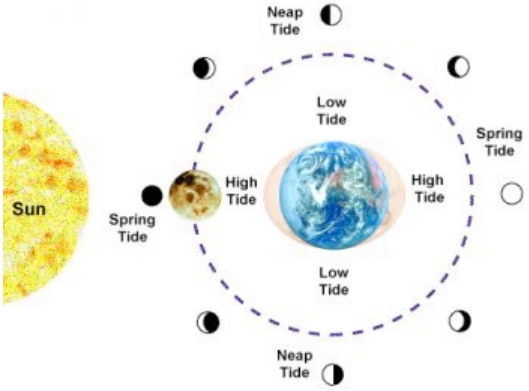
Oceanography SOL Review

Oceans
- is a dynamic system in which many chemical, biological, and physical changes are taking place
  - large current systems present in the oceans that carry warm water toward the poles and cold water toward the equator - created by *Coriolis Effect* and *wind*
  - sea level falls when glacial ice caps grow and rises when the ice caps melt
- are environmentally and economically important
  - algae in the oceans are an important source of atmospheric oxygen
  - are an important source of food and mineral resources as well as a venue for recreation and transportation
  - human activities and public policy have important consequences for the oceans
  - its resources are finite and can be overexploited
  - impact of human activities such as waste disposal, construction, and agriculture affect the water quality within watershed systems and ultimately the oceans
  - pollution and over-fishing can harm or deplete valuable resources
  - chemical pollution and sedimentation are great threats to the chemical and biological well-being of estuaries and oceans
- is the single largest reservoir of heat at the Earth's surface
  - *convection* is the major mechanism of energy transfer between the oceans, atmosphere, and the Earth's interior
  - stored heat in the ocean drives much of the Earth's weather and causes climate near the ocean to be milder than climate in the interior of the continents

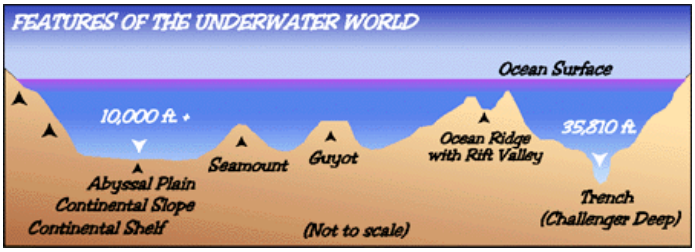
Estuaries
- *Chesapeake Bay* is an example
- are areas where fresh and salt water mix → produces variations in salinity and high biological activity

Upwellings
- bring cold, nutrient-rich water from the deep ocean to the surface and are areas of rich biological activity

Tides
- are the daily, periodic rise and fall of the water level caused by the gravitational pull of the sun and the moon



Topographic Features
- seafloor topography is at least as variable as that on the continents
- features related to plate tectonic processes include mid-ocean ridges and trenches
  other major topographic features of the oceans include continental shelves, continental slopes (have canyons; extreme sediment movements), abyssal plains (flattest area on Earth; quickly fills with sediments), and seamounts (underwater volcanoes)

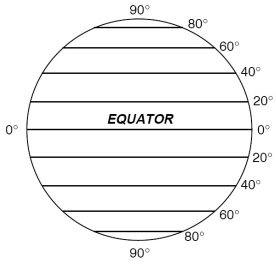


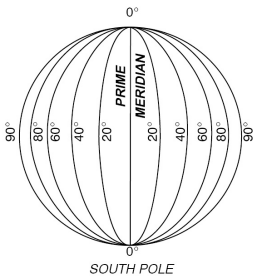
Scientific Investigation SOL Review

Density
- density = mass/volume
- units: g/mL or g/cm^3
- is the same no matter how much of an object you have at the same temperature

Experimental Design
- there can be more than one explanation for any phenomena
- ***hypothesis***: can be supported, modified, or rejected based on collected data
  - are tentative explanations that account for a series of facts and can be tested by further investigation
  - experiments are designed to test hypotheses
  - any valid hypothesis can be tested
- ***scientific laws***: generalizations of observation data that describe patterns and relationships
  - may change as new data becomes available
- ***scientific theories***: are systematic steps of concepts that offer explanations for observed patterns in nature
  - provide frameworks for relating data and guiding future research
  - may change as new data becomes available
  - any valid scientific theory has passed tests designed to invalidate
- ***conclusions***: are only as good as the quality of the collected data

Maps
- map scale: relates unit of length on a map to actual distance
- latitude: lines run parallel to the equator; measure north and south
- longitude: lines intersect at the poles; measure east and west
- 60 minutes in 1 degree; 60 seconds in 1 minute
- equator: 0° latitude
- prime meridian: 0° longitude





Topographic Maps
- shows the shape of the Earth's surface using contour lines
- ***contour lines***: imaginary lines that join points of equal elevation on the surface of the land above and below a reference surface (can be sea level)
- includes symbols for streets, buildings, streams, vegetation
- measure changes in elevation
- when contour lines are close together, the area is steep (getting closer to *hilltops)*
- depressions or holes are identified by lines within a circle
- *valleys* will have contour lines very spread apart