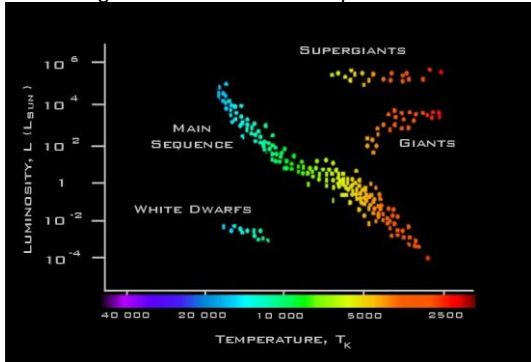


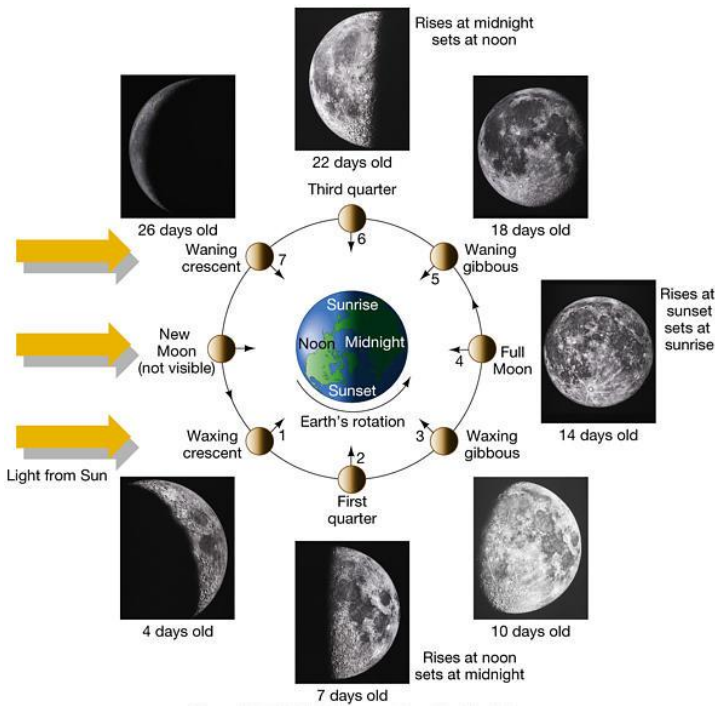
Astronomy SOL Review

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

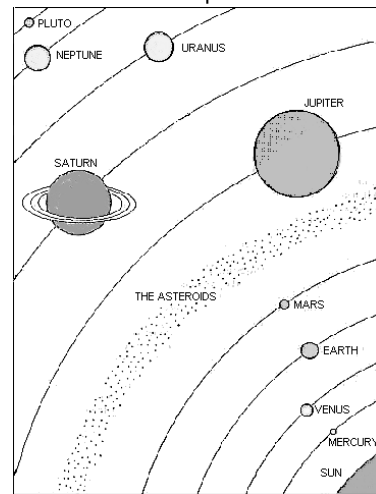


Solar System

- 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 than 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, temperate, tropical
- both weather and climate are measurable to an extent predictable

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

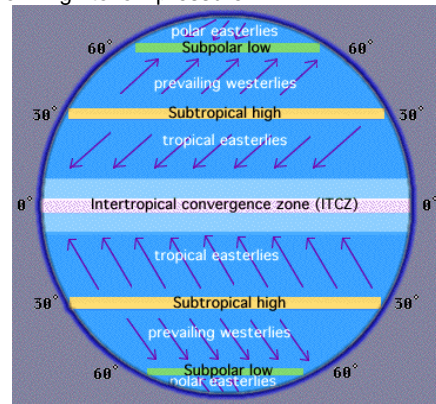
combinations of these can be made,
e.g. ▽● rain shower, ✱▽ snow shower

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

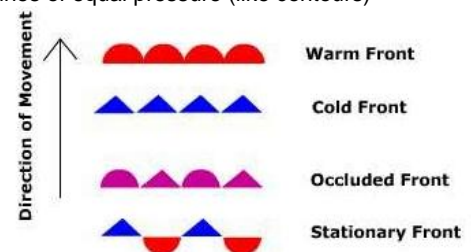
- the conditions for **cloud formation** are air at or below the dew point and the presence of condensation nuclei
- cloud droplets can join together to form **precipitation**
- **types**: cirrus: light, thin, feathery (fair weather clouds); cumulus: puffy white clouds; stratus: low gray clouds

Measuring Devices

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

Weather Maps

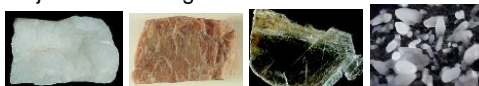
- weather moves from west to east in the US
- symbols for cold fronts, warm fronts, pressure and precipitation should be known
 - high pressure (H): fair weather, circulates clockwise and air sink
 - low pressure (L): bad weather, circulates counterclockwise and air rises
 - air from high pressure always 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



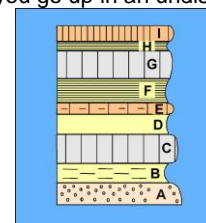
marble quartzite

Fossils

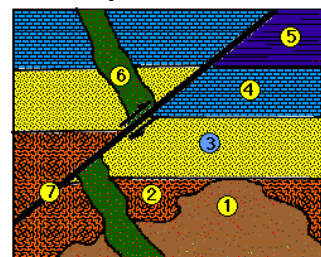
- is the remains, impressions or other evidence preserved in rock of the former existence of life (can be ancient or often extinct)
- some ways fossils can be preserved include molds, casts, and original bone or shell
- nearly all fossils are found in sedimentary rocks
- fossil evidence indicates that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

Dating

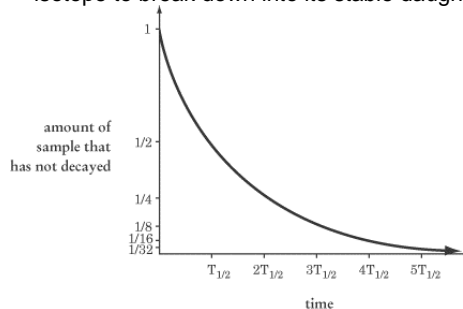
- Earth is very ancient → about 4.6 billion years old
- history of Earth and age of rocks can be investigated and understood by studying rocks and fossils
- **relative time** places events in a sequence without assigning any numerical ages
 - fossils, law of superposition, and law of crosscutting relationships 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

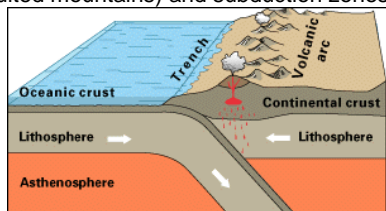
- three major divisions: eras, periods, epochs
 - **eras:** largest division → ends with extinction events
 - **periods:** based on index fossils (abundant, worldwide, short-lived)
 - **epochs:** smallest; based on types of life (only in Cenozoic Era)
- **Precambrian Era:** 90% of all geologic history
 - 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

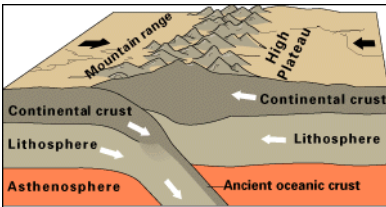
- solid, mostly iron inner core; a liquid, mostly iron outer core; a rocky, plastic mantle; and a rocky, brittle crust
- core, mantle, and crust are dynamic systems – constantly in motion
- two types of crust: oceanic and continental → each has very different characteristics
 - ocean (basalt) crust is 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

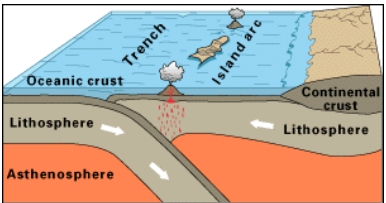
- **lithosphere**: made of Earth's crust and some of mantle; is divided into plates that are in motion with respect to one another
- plate motion occurs as a consequence of convection in the Earth's mantle
- plate tectonics is driven by convection in the Earth's mantle
- relative plate motions and plate 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

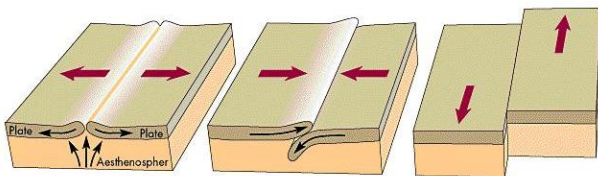


continent-continent



ocean-ocean

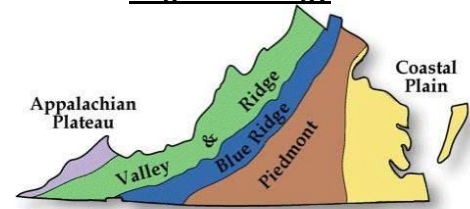
- **divergent boundaries' features**: mid-ocean ridges, rift valleys, and fissure volcanoes
- **transform boundaries' features**: strike-slip faults – San Andreas Fault



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
- **faults** 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

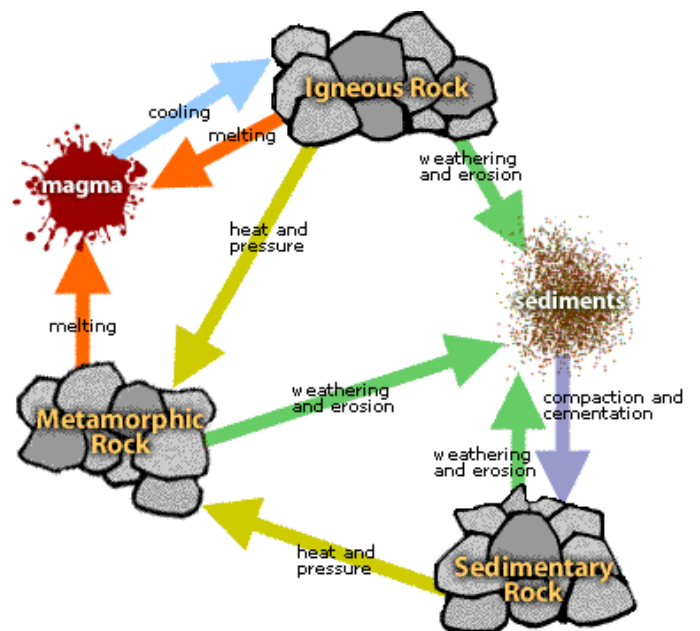
Virginia Geology



- **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

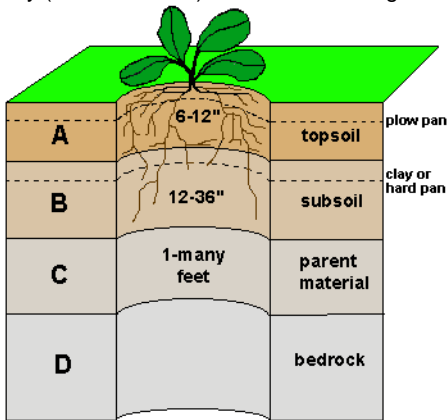


Weathering and Erosion

- 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

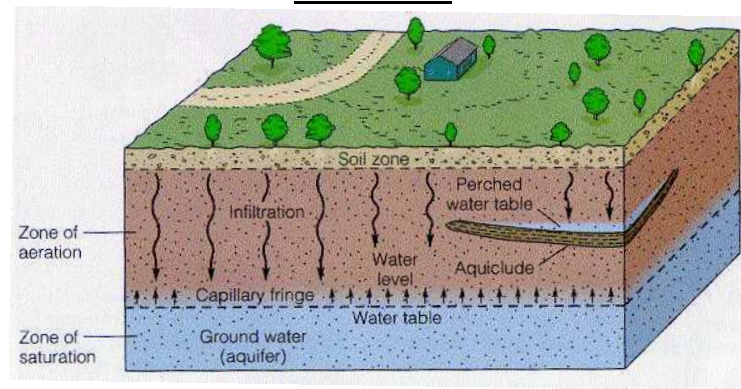
Karst topography

- 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

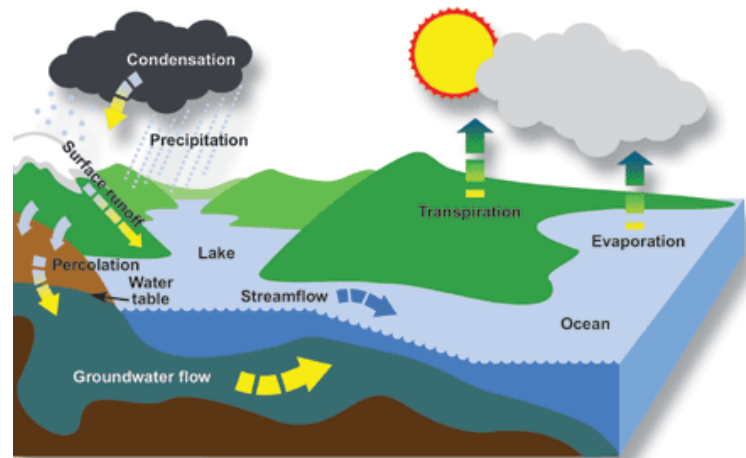
- a substantial amount of water is stored in permeable soil and rock underground
 - **permeability**: measure of the ability of a rock or sediment to transmit water or other liquids (gravel, sand)
 - water doesn't pass through impermeable materials (clay)
- Earth's water supply is finite
 - geological 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

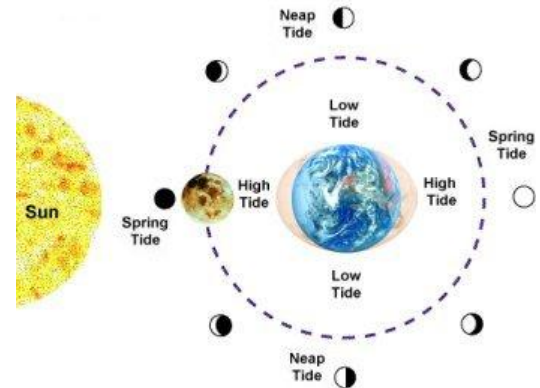
- Chesapeake Bay is an example
- are areas where fresh and salt water mix → produces variations in salinity and high biological activity

Upwellings

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

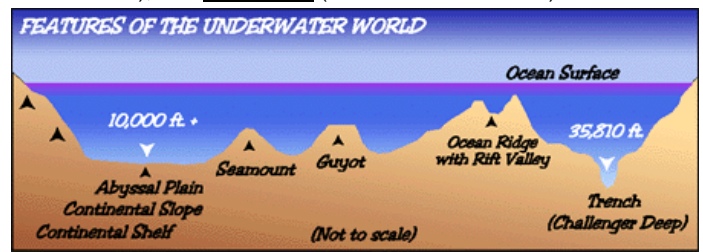
Tides

- 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

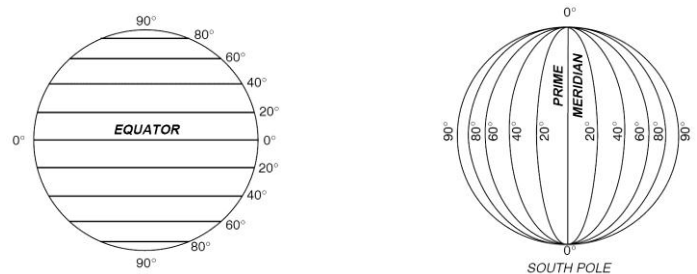
- density = mass/volume
- units: g/mL or g/cm³
- is the same no matter how much of an object you have at the same temperature

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 it
- **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

