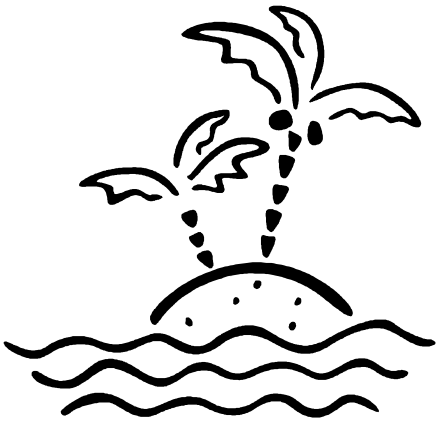
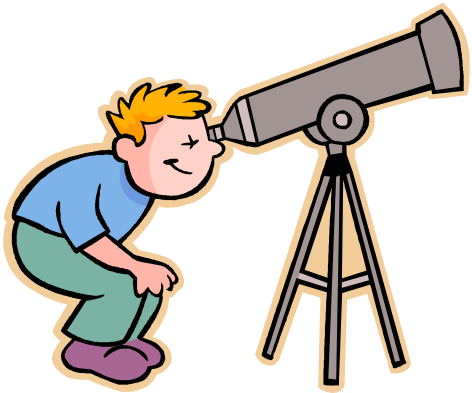
Name: _____ Pd.: _____

Review and Practice for the Earth Science SOL





A review and study guide for the Virginia End of Course Standards of Learning Assessment for Earth Science

Written and assembled by D. L. Edwards with input from other valued teachers throughout Virginia. Strasburg High School, Strasburg, VA, May/June, 2008; Revised May 2010

Review and Practice for the Earth Science SOL

Table of Contents

Record the Date, time and location of your Earth Science SOL

Spend time reading the Essential Questions shown with each unit. See if you can answer the questions that are being asked. If you are having difficulty answering questions in a particular unit, spend more time reviewing those sections in the pages that discusses each topic. Analyze the Sample SOL Questions provided with each unit. There should be at least one sample question for each topic within a given unit.

Please study this information well. Knowing this information will make an enormous difference in your success on the SOL. Study it often. Read over it at least once a day. You will get to the point where you are tired of reading it because it has become so familiar…this is a good thing! It means that you are learning it and your brain is storing it. Spend time reviewing the graphic organizer pages and add information as necessary. You may find there are things that would be helpful to add…please do!

Remember, what you get out of something is directly proportional to what you put into it. If you put in the time and effort preparing, you will be rewarded with a passing score.

I wish you success on all of your SOL's!…not just this one.

Words of wisdom: If you always do what you always did, you'll always get what you always got!

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Scientific Investigation

(ES. 1a-e, 2a-e)

ES.1 The student will plan and conduct investigations in which…

- ☐ a) volume, area, mass, elapsed time, direction, temperature, pressure, distance, density, and changes in elevation/depth are calculated utilizing the most appropriate tools;
- ☐ b) technologies, including computers, probe ware, and global positioning systems (GPS) are used to collect, analyze, and report data and to demonstrate concepts and simulate experimental conditions;
- ☐ c) scales, diagrams, maps, charts, graphs, tables, and profiles are constructed and interpreted;
- ☐ d) variables are manipulated with repeated trials;
- ☐ e) a scientific viewpoint is constructed and defended (the nature of science).

ES.2 The student will demonstrate scientific reasoning and logic by…

- ☐ a) analyzing how science explains and predicts the interactions and dynamics of complex Earth systems;
- ☐ b) recognizing that evidence is required to evaluate hypotheses and explanations;
- ☐ c) comparing different scientific explanations for a set of observations about the Earth;
- ☐ d) explaining that observation and logic are essential for reaching a conclusion; and
- ☐ e) evaluating evidence for scientific theories.

Essential Questions

You should be able to answer the following questions with confidence about this topic.

- ☐ Scientists ask and answer questions and compare the answers with what is already known. How do scientists ask and answer questions?
- ☐ Scientists plan and conduct experiments and use tools to gather and verify data. How do scientists conduct and verify data?
- ☐ How do scientists plan experiments?
- ☐ How do scientists use systematic processes to test hypotheses?
- ☐ How does the type of question determine the type of investigation?
- ☐ Scientists use reasoning and logic to analyze and interpret data, reach a scientific conclusion and communicate their results. How do scientists use reasoning and logic to communicate their results?

Part One: The Scientific Method

In any scientific investigation there are 6 basic steps:

- determine the ***problem*** – This starts with an observation that leads to a question. For example, "We are experiencing increasing temperatures worldwide. What role does the use of fossil fuels have on these temperature increases." Standard format: "What is the effect of the (independent variable) on the (dependent variable)?"
- ***research*** your experiment – See if there are others who have conducted similar experiments. Determine how the item you are experimenting on should behave under normal conditions. This is also where you should set up a ***procedure***, a step by step list of what to do, so others who conduct your experiment can see if they get the same results.
- make a ***hypothesis*** – This is a possible explanation or solution to or outcome of an experimental problem. Standard format: "If you (change how) the (independent variable), then the (dependent variable) will (change how)."
- ***test*** the hypothesis – This is the part where you collect data and carefully record it in your ***data table***. You should make every attempt to set your experiment up so you can perform multiple ***trials*** for the best results. One try in an experiment will not get the best results.
- ***analyze*** the results – This is the part where you perform calculations (like averaging) of your data.
- draw ***conclusions*** – This is the part of the experiment where you compare your results back to your original hypothesis. Standard format: "The hypothesis (was or was not) supported by the data because (make comparisons between hypothesis and data)."
- Once a hypothesis has been tested many times, it becomes a ***theory***. When the time comes that all tests prove the hypothesis every time and this hypothesis will be true every time it is tested, it is then considered to be a ***law***.

Key Vocabulary: conclusion, data table, hypothesis, law, problem, procedure, research, test, theory, trial

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Part Two: Variables and Constants

Variables are the things that change in an experiment. There are two variables.

- The ***independent variable*** is changed by the experimenter.
- The ***dependent variable*** responds to the changes in the independent variable.

On a graph of plotted experiment data...

- the independent variable is plotted on the ***x-axis*** (horizontal)
- the dependent variable is plotted on the ***y-axis*** (vertical).

The ***constants*** (controlled variables) are the things that you keep the same.

The ***control*** is the part of the experiment where the independent variable is not manipulated or is absent. It is the standard for comparison. This will allow you to make decisions on the outcome of your experiment. It is the part of the experiment that you compare your results to in order to see if your hypothesis was or was not supported by the data.

The difference between tables and graphs...

- A ***table*** is what you use to record data.
- The data gets plotted on to a chart or ***graph***.

Key Vocabulary: constant, control, dependent variable, graph, independent variable, table, x-axis, y-axis

Part Three: Measurement

The International System of Units (***SI unit***) is the measuring system used by most people around the world. It is the modern version of the ***metric system***.

- The ***meter*** (m) – used to measure ***length***.
- The ***liter*** (L) is the unit of volume, it is a measure of how much space an object occupies. Liquids are measured in liters.
- Regular solids are measured in cm^3 : L x W x H= V.
- The ***volume*** of an irregular object is found by ***water displacement***.
- ***Mass*** is a measure of the amount of matter in an object. The SI unit of mass is the ***gram*** (g).
- Gravity is a pull which all matter exerts on all other matter, the more mass, the stronger the pull.
- ***Weight*** is a measure of the pull of the earth's gravity on an object.

There are 3 main states of matter: ***solid***, ***liquid***, ***gas***

Key Vocabulary: gas, gram, length, liquid, liter, mass, meter, metric system, SI unit, solid, temperature, volume, weight

Part Four: Density

Density is a measure of the amount of matter that occupies a particular space. It is determined by dividing the mass of an object by its volume.

- The formula for density is: ***Density = Mass / Volume***.
- The SI units are g/cm^3 or g/mL.
- Density measures how tightly packed the molecules in a substance are.
- Example: If a rock has a volume of $20cm^3$ and a mass of 30g. What is the density? D = 30g / $20cm^3$ = 1.5g / cm^3.
- Warm (air, water, magma) rises because it is less dense. Cold (air, water, magma) sinks because it is more dense. As pressure increases so does density.
- ***Specific Gravity*** is the comparison of the density of a substance to the density of water.

Key Vocabulary: mass, volume, density, specific gravity, water displacement

Sample SOL Questions

1. Which would be the best tools to measure the density of a small piece of silver ore?

A A barometer and a balance
B A density probe and a 500 mL beaker
C A metric ruler and a metal detector
D A graduated cylinder and a balance

2. Which of the following puts the steps of a scientific experiment in the correct order?

A 2, 1, 3, 4 **B** 4, 2, 3, 1 **C** 2, 1, 4, 3 **D** 2, 3, 1, 4

1. Propose an outcome
2. State the problem
3. Make a Conclusion
4. Gather Data

3. A student found the rock shown here and weighed it to determine its mass. What steps should the student take to find its density?

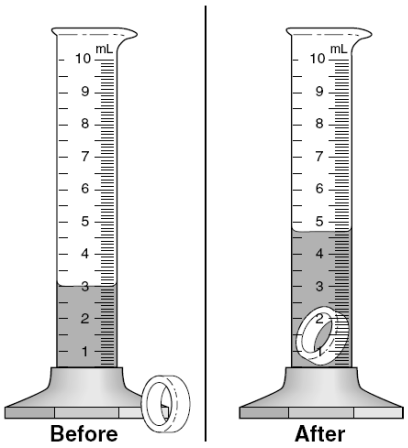
A Determine its volume by how much water it displaces, then divide mass by volume.
B Determine its volume by multiplying length x width x height, the divide mass by volume.
C Crush the rock to a powder and measure its volume in a graduated cylinder, then divide mass by volume.
D Determine its volume using the formula for the volume of a sphere ($V = 4/3\pi r^3$), then divide mass by volume.

4. A student set up an experiment to test the effects of soil compaction on plant growth. The student put equal weights of moist soil into 10 containers, planted a bean seed one inch deep in each container, and then firmly compacted the soil in 5 of the containers. After the seeds sprouted, the student measured the height of each plant every day and kept a record of the results. What else must the student do over time to ensure a valid experiment?

F Water any of the plants that seem to be growing more slowly than the others
G Water the plants in compacted soil more than those in uncompacted soil
H Water all of the containers the same amount and at the same time
J Water any container in which the soil feels dry

5. One step in determining the metal content of a ring is to find the volume of the ring. What is the volume of this ring?

A 1.7 mL **B** 3.0 mL **C** 4.7 mL **D** 7.1 mL

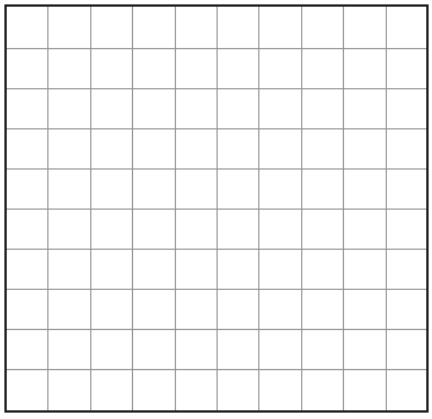


6. The table below shows the results of an experiment.

EVAPORATION

Temperature (°C)	Amount of Water Evaporated (mL)			Average Amount of Water Evaporated (mL)
30	1.8	2.1	2.1	**2.0**
45	6.3	5.6	6.1	**6.0**
60	11.5	11.0	10.5	**11.0**
75	21.1	21.2	19.7	**21.0**

Use the grid below to construct a **line graph** showing the relationship between the temperatures of the water and the average amount of water that evaporated. Be sure to title your graph, label each axis, and indicate the appropriate units for each axis.



Application-This is where YOU do the work!!!

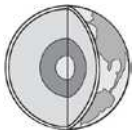
One the following page, you will find diagrams to label, information to be completed or questions to be answered. Please complete the page accurately and study the information contained there.

The 4 Branches of Earth Science:

Geology – the study of _____

_____

_____



Oceanography – the study of _____

_____

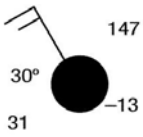
_____

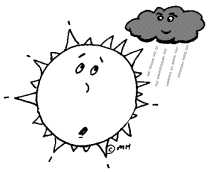
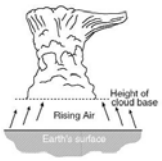


Meteorology – the study of _____

_____

_____

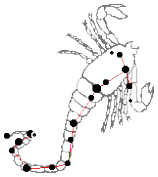


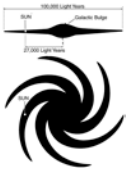



Astronomy – the study of _____

_____

_____





Scientific Method Definitions:

Hypothesis - _____

_____

Independent Variable - _____

_____

Dependent Variable - _____

_____

Constant - _____

_____

Control - _____

_____

Conclusion - _____

_____

Density: Calculate the density of the following mineral samples and plot the data on the graph.

Sample # 1: mass= 90g, volume= 30mL

Sample # 2: mass= 75g, volume= 25mL

Sample # 3: mass= 60g, volume= 20mL

Measurements:

SI for distance/length: _____

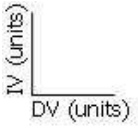
SI for volume: _____ or _____

SI for mass: _____

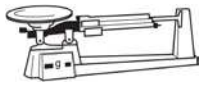
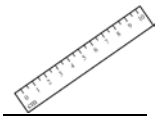
SI for density of regular solids: _____

SI for density of irregular solids: _____

SI for temperature: _____



Measuring Tools: indicate what SI unit is determined when using these tools and what they are used to measure.


_____ _____ _____

_____ _____ _____

Mapping the Earth

(ES. 3a-d)

ES.3 The student will investigate and understand how to read and interpret maps, globes, models, charts, and imagery. Key concepts include...

- ☐ a) maps (bathymetric, geologic, topographic, and weather) and star charts;
- ☐ b) imagery (aerial photography and satellite images);
- ☐ c) direction and measurements of distance on any map or globe; and
- ☐ d) location by latitude and longitude and topographic profiles.

Essential Questions

You should be able to answer the following question with confidence about this topic.

- ☐ Scientists use maps, globes, models, charts, technology and imagery to interpret and measure the world. How do they use these tools to interpret the world?

Part One: Latitude and Longitude and Basic Map Reading

Scientists use many different types of maps to relate information. Here are a few of them and what they show...

- Road map – shows the locations of primary and secondary roadways, cities, places of interest
- Topographic map – shows the elevation of a specific location (see Part Two for more detail)
- Bathymetric map – shows the depths of the ocean floor or large bodies of water
- Geologic map – shows the underlying geologic formations, fault lines, etc. of an area
- Star Chart – a map showing the location of constellations, planets, and deep sky objects in the sky
- Weather Map – a map showing current or forecast weather conditions for an area
- Physical Relief map – a map that uses color and shading to indicate differences in elevation
- Globe – a map of the world on a sphere (the most accurate projection)

An imaginary grid system is used on Earth to precisely locate places.

- ***Latitude*** lines show distance in degrees North and South of the ***equator***.
- The Northern Hemisphere runs from 0° to the North Pole.
- The Southern Hemisphere runs from 0° to the South Pole. Latitude lines are referred to as ***parallels***.
- The key numbers to remember for latitude are: Equator (0°), North Pole (90°N) South Pole (90°S).
- ***Longitude*** lines show distance in degrees East and West of the ***Prime Meridian***.
- Longitude lines are referred to as ***meridians***.
- The Prime Meridian is 0° longitude (runs through Greenwich, England).
- The ***International Date Line*** is 180° longitude (halfway around the Earth from the Prime Meridian, halfway between China and California in the middle of the Pacific Ocean). It is the highest number that can be used for longitude and it doesn't need an East or West label.
- Meridians are closer together at the poles, further apart at the equator. They converge at the poles.
- Parallels NEVER meet.
- When stating locations using latitude and longitude you must always put the latitude (N/S) first and the longitude (E/W) second, separated by a comma. For example, 39°N, 78°W. Together these are called the ***coordinates*** of a location.
- The latitude and longitude measurements are expressed in ***degrees***.
- Degrees can be separated into 60 ***minutes*** and they are represented by an apostrophe. For example, 39°30'.
- Those can be further divided into 60 ***seconds*** and they are represented by quotation marks. For example, 39°30'28".

The world can be divided into ***hemispheres*** which means half of a sphere. They are:

- Northern – the portion of the world that is north of the Equator
- Southern – the portion of the world that is south the Equator
- Eastern – the portion of the world that is east of the Prime Meridian
- Western – the portion of the world that is west of the Prime Meridian
- Every location on Earth is either north or south of the Equator AND east or west of the Prime Meridian. This will directly relate to the latitude/longitude coordinates.

Things you find on a map to help you identify features:

- ***compass rose*** – This appears in many different forms but is also referred to as the North Arrow because it shows you where north is in relation to the map you are observing.

- ***legend*** – This is a section of the map that shows you what the different symbols mean. You will usually find symbols for different road types, schools, parks, airports, hospitals, etc.
- ***map scale*** – This is a method for telling you what the relationship between the paper and the ground is mathematically. There are 3 types:
  - The ***bar scale*** (also called a graphic scale) shows you what the distance on the paper is that represents a mile or a kilometer.
  - The ***verbal scale*** is where the map will tell you what distance on the map is compared to the ground, like 1" = 1 mile.
  - The ***representative scale*** is a ratio…1:100,000 for example. This would mean 1 unit on the paper is equal to 100,000 of the same units on the ground. This is useful for any units. In the example mentioned, 1 centimeter on paper is equal to 100,000 centimeters on the ground, or 1 inch on paper is equal to 100,000 inches on the ground. You can use any units you like.

There are 24 standard ***time zones***.

- Each one covers about 15° of longitude, which is determined by taking the 360° for the sphere of the Earth and dividing it by 24 hours in a day.
- Each zone covers approximately 15° of longitude, with 7½° on each side of the center of the zone. For example, at the Prime Meridian (0° longitude) the zone covers 7½° east of that line and 7½° west of that line.
- For the continental United States, the names of the zones, beginning on the east coast are: Eastern, Central, Mountain and Pacific with each zone being 1 hour behind as you move from east to west.

Key Vocabulary: bar scale, compass rose, coordinates, degree, Equator, hemisphere, International Date Line, latitude, legend, longitude, map scale, meridian, minute, parallel, Prime Meridian, representative scale, second, time zones, verbal scale

Part Two: Topographic Maps

Topographic Maps show relief using ***contour*** lines. Relief is the highs and lows of the land.
Elevation refers to the height above sea level of a certain place.
Contour lines are lines drawn to connect points of the same elevation.
A ***contour interval*** is the difference in elevation between neighboring contour lines.
To make reading easier, on most maps, some lines are made heavier and the elevation marked…***index contour***.
A depression is a lower point on Earth than the surrounding area. These are shown on the topographic maps by placing tic marks that point towards the center…called ***hachure*** lines. Example: a crater, a sinkhole.
Gentle slopes are indicated by wide spaces between contour lines.
Steep slopes are indicated by contour lines that are very close together. In fact, 'The closer the lines, the steeper the climb'.
A ***profile*** is a vertical section or side view.
Hilltops are shown by concentric contour lines and the number values are going up.
Valleys are indicated by a change in contour intervals with the number values going down.
Rivers and streams are shown with a v contour line. The *V always points upstream*.
A marked point of known and documented elevation is a ***benchmark***.
A ***bathymetric map*** measures water depth across an underwater sea
Key Vocabulary: benchmark, contour, contour interval, elevation, gentle slope, hachure, index contour, profile, steep slope, topographic map

Part Three: Global Positioning Systems

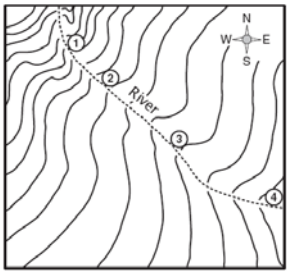
Global Positioning Systems (***GPS***) are used to identify places on Earth. It uses a system of ***satellites*** (24) that orbit the Earth, send out radio signals and communicate with base stations (or control stations) and user equipment. You need at least THREE satellites to find a 3-D loction.
Things GPS *can* tell you:

- ***Latitude/Longitude***
- Speed of travel and direction of travel
- ***elevation***

Things GPS *cannot* tell you: temperature (that's measured by a thermometer…but you knew that!…right?)
When using a hand held unit, you record locations by marking them with a ***waypoint***.
Key Vocabulary: elevation, GPS, latitude, longitude, satellite, waypoint

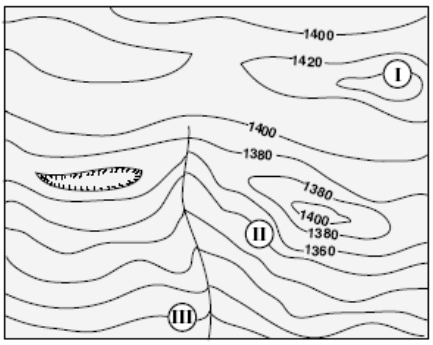
Sample SOL Questions

1. The river shown on the topographic map flows fastest at point —



F 1
G 2
H 3
J 4

2. On the topographic map provided, what is the elevation of point III?

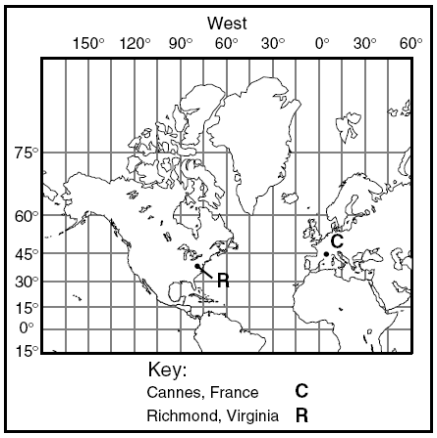


A 1260 feet
B 1280 feet
C 1300 feet
D 1360 feet

3. When contour lines are spaced far apart, the area shown on a topographic map has-

A gentle slopes
B perfectly flat land
C steep slopes
D rivers or streams

4. The longitude of Richmond, Virginia, on the map to the right is approximately —

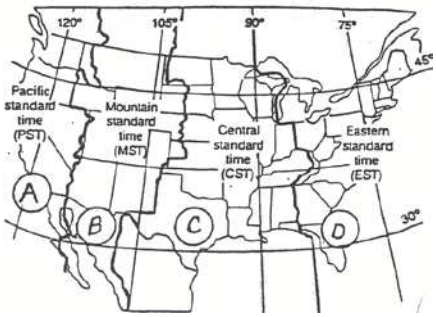


F 75° W
G 38° N
H 38° W
J 75° N

5. Two cities on a map are 15 cm apart with a scale of 1 cm= 20km. How far apart are the cities on Earth?

F 75 km
G 150 km
H 300 km
J 500 km

6. Virginia is located in which time zone?



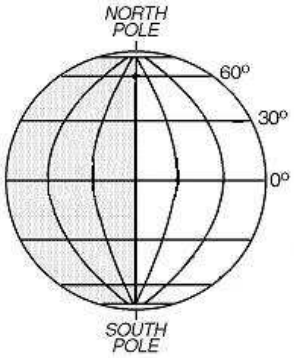
A A
B B
C C
D D

There have been no released SOL test questions for GPS!...yet.

Application

One the following page, you will find diagrams to label, information to be completed or questions to be answered. Please complete the page accurately and study the information contained there.

General Mapping:



Latitude lines run _____/_____ but they always measure _____/_____ of the _____.
The highest measurement is _____ °N or _____ °S.
The lowest measurement is 0° at the _____.
Longitude lines run _____/_____ but they always measure _____/_____ of the _____ _____. The highest measurement is _____ ° which is called the _____ _____ _____. The lowest measurement is 0° at the _____.
Label a latitude line and a longitude line on the globe shown above.

GPS: _____

_____

_____

3 Basic components:

1. _____
2. _____
3. _____

Allows you to find:

1. _____
2. _____
3. _____
4. _____

Major uses:

_____

_____

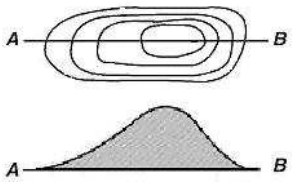
Topographic Profiles:

_____

_____

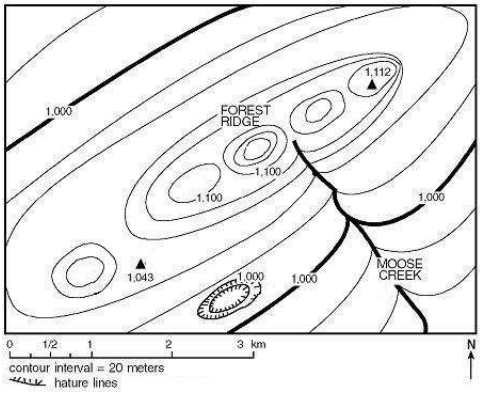
_____

_____



Topographic Maps: After defining the following terms, label the topographic map with the number of the term.

1. contour line – _____
   _____
2. index contour – _____
   _____
3. hachure line – _____
   _____
4. benchmark – _____
   _____
5. contour interval – _____
   _____



6. How you know where the river is – _____

Color an area of gentle slopes in one color and steep slopes in another. ☐ steep ☐ gentle

Things topographic maps show: _____

_____

General map features: _____

_____

Minerals and Rocks

(ES. 5a, b, 6a-c)

ES.5 The student will investigate and understand how to identify major rock-forming and ore minerals based on physical and chemical properties. Key concepts include:

- ☐ a) properties including hardness, color and streak, luster, cleavage, fracture, and unique properties;
- ☐ b) uses of minerals.

ES.6 The student will investigate and understand how to identify common rock types based on mineral composition and textures and the rock cycle as it relates to the origin and transformation of rock types. Key concepts include:

- ☐ a) igneous (intrusive and extrusive);
- ☐ b) sedimentary (clastic and chemical);
- ☐ c) metamorphic (foliated and unfoliated) rocks.

Essential Questions

You should be able to answer the following question with confidence about this topic.

- ☐ Earth undergoes regular patterns of change and natural cycles, both quickly and over time. Explain how minerals and rocks are a result of Earth's regular patterns of change and natural cycles.
- ☐ Mineral resources affect our everyday life. How do mineral resources affect our everyday life?
- ☐ Scientific evidence found in various types of rock is used to identify past events and environments. Describe how rocks are used to identify past events and environments.
- ☐ Mineral and rock resources are limited and their use impacts the environment and economy. Describe why minerals and rock resources are limited.
- ☐ How does the use of mineral and rock resources affect our environment and economy?

Part One: Properties of Minerals

There are four basic characteristics of minerals. All minerals are…

- formed by ***natural*** processes
- ***inorganic*** solids
- ***elements*** or ***compounds*** with a chemical composition unique to that mineral
- ***crystal*** structures; that is the atoms in minerals are arranged in a pattern that is repeated over and over again.

Minerals are formed out of molten earth material or magma, or when water containing dissolved ions evaporates, i.e. halite (salt) from evaporating sea water.

Minerals can be changed into different minerals by heat, pressure, or the chemical action of water.

Minerals are classified according to ***composition***, classes are**:** ***silicates*** (formed mostly from silicon and oxygen), ***carbonates*** (formed from the shells and skeletons of marine organism), sulfides, sulfates, halides, hydroxides, and phosphates.

Key Vocabulary: carbonates, composition, compound, crystal, element, inorganic, mineral, natural, silicates

Part Two: Mineral Identification

Mineral identification refers to the way to tell one mineral from another.

- The ***color*** is the most obvious but one of the least reliable methods of identifying minerals.
- ***Hardness*** is a measure of how easily a mineral can be scratched. The ***Mohs*** hardness scale lists hardness of ten minerals with 1 being softest and 10 the hardest. We can determine the approximate hardness of a mineral by running a group of tests. Scratch the mineral in question with a fingernail, penny, iron nail, or glass slide. If the mineral shows a scratch mark from one of the testing materials, the mineral is said to be less hard than the mineral that scratched it. Example: A piece of pink feldspar will not be scratched by a fingernail, penny, or an iron nail, but will be scratched by a glass slide. The feldspar is said to be harder than the first three testing materials but not as hard as the glass slide.
- ***Luster*** describes how light is reflected from a mineral's surface. Luster gives you an indication of how metallic looking a mineral is. The two main ways that geologists categorize a mineral's luster is metallic or non-metallic. ***Metallic*** minerals look like metal (they may or may not be shiny), while ***non-metallic*** minerals vary greatly in their appearance and are usually described as shiny, pearly, waxy, glassy, etc.
- ***Streak*** is the color of the mineral when it is broken up into powder. Streak is a test used by a geologist to see the color of the mineral under the top layer or coating on the mineral. The mineral is rubbed on a "streak plate", which is a piece of porcelain. When the mineral is rubbed across the streak plate some of the mineral is broken off and ground into a powder. This allows the geologist to see under the outer layer

which could have a different color due to the mineral being exposed to the atmosphere. When minerals are exposed to the atmosphere, gasses like oxygen can chemically combine with the mineral to change its outer color.

- ***Cleavage & Fracture*** refer to the way the mineral breaks. Some minerals have a tendency to split or crack along parallel or flat ***planes***. This property is easily seen in some minerals and you can test the mineral by breaking it with a hammer or splitting off sheets with a pen knife. These planes along which the mineral breaks are called cleavage planes. If the mineral splits easily along these planes the mineral is then said to have perfect cleavage. Fracture is related to cleavage. Fracture occurs when a mineral breaks at random lines instead of at consistent cleavage planes. Many minerals that have no cleavage or poor cleavage fracture easily.
- Some minerals have the same color and streak. In order to tell them apart you can perform an ***acid test***. You can use something as weak as vinegar. If it bubbles and fizzes (reacting with the carbon dioxide in the mineral) it is a carbonate mineral.
- One other test that you can perform is to determine a mineral's density. When that density is compared to water it is called ***specific gravity***.

Key Vocabulary: acid test, cleavage, color, fracture, hardness, luster, metallic, Mohs, non-metallic, plane, specific gravity, streak

Part Three: Mineral Resources

Minerals are very important and have many uses.

- ***Gems*** are highly prized minerals because they are rare and beautiful. An example of this would be a ***diamond*** which is the hardest mineral known.
- ***Ores*** are minerals that contain a useful substance that can be mined at a profit.
- Examples: ***Bauxite*** can be refined to make aluminum. ***Hematite*** can be refined to make iron. ***Halite*** is salt. ***Graphite*** is used to make pencil leads and as an industrial lubricant. ***Sulfur*** is widely used in medicines. ***Magnetite*** is used as magnets. ***Talc*** is used to make powder.

Rock forming minerals:

- ***Feldspars*** are the most abundant minerals found on the surface of the Earth. Feldspars can be glassy white, pink, and a variety of other colors. They contain silica, aluminum and potassium.
- ***Clays*** are usually composed of weathered feldspar.
- ***Micas*** are minerals that can be split into very thin sheets. Mica can be clear to very dark green or black in color.
- ***Hornblende*** is a mineral that is composed of magnesium, iron, silica, and aluminum. It is found in many igneous rocks.
- ***Quartz*** is a very common mineral that is found on the surface of the Earth. Its chemical formula is SiO_2 (silicon dioxide). Sand is quartz crystals that have been weathered into small pieces.
- ***Galena*** is unique because it is extremely heavy compared to its size. In other words, it has a high specific gravity.
- In Virginia, some of the important minerals are ***kyanite*** and ***pyrite***. Additionally, ***calcite*** is found in every cavern in Virginia and formed from the breakdown of limestone by acidic water. It will bubble and fizz when a weak acid is applied.

Key Vocabulary: bauxite, calcite, clay, diamond, feldspar, galena, gem, graphite, halite, hematite, hornblende, kyanite, magnetite, mica, ore, pyrite, quartz, sulfur, talc

Part Four: Rock Identification and Rock Types

The solid part of the earth is composed of substances collectively known as ***rock***.
Nearly every rock is composed of one or more naturally occurring inorganic crystalline substances called ***minerals***.
The three main rock classifications are Igneous, Sedimentary, and Metamorphic.
Rocks are classified into these groups by the way they were formed.
Igneous rock…

- is molten material from a volcano (***lava***) or from deep inside the earth (***magma***) which ***cools*** and ***hardens***
- comes from the Latin word *ignis* which means "fire"
- are usually found near ***volcanoes*** or ***divergent*** boundaries (separating plates)
- are classified by composition and texture
- ***Extrusive*** Igneous *Rock (Volcanic)* is formed on Earth's surface when molten rock flows out of the earth (lava) and cools quickly at the surface to form fine crystals. Rocks formed in this way have a fine – grained texture. Examples of extrusive igneous rocks are ***Pumice***, ***Basalt***, and ***Obsidian***.

- ***Intrusive*** Igneous *Rock (Plutonic)* is formed in the Earth when molten rock flows upward into the more solid part of the crust. Rocks formed this way have a coarse – grained texture. ***Granite*** is an example of an intrusive igneous rock.

Sedimentary rock …

- can form from particles of rock, from remains of plants or animals, or from chemical reactions
- are classified by their composition and by the way they were formed
- are formed from the ***compaction*** and ***cementation*** of small pieces of rocks or shells are called sedimentary rocks
- are usually found near ***water***
- are found in flat layers or strata. ***Fossils*** are found in these layers.
- ***Clastic*** sedimentary rocks come from fragments of other rocks. Examples: ***Shale***, ***Sandstone***.
- ***Non-clastic organic*** sedimentary rock comes from the remains of organisms. Examples: ***coal***, ***limestone***.
- ***Non-clastic chemical*** sedimentary rock is formed when mineral grains dissolved in water are precipitated or are left behind when a solution evaporates. Examples: ***rock salt***, ***gypsum***.

Metamorphic rock…

- forms from other rocks by ***heat*** and ***pressure***
- are usually found near ***convergent*** boundaries (plates coming together)
- are classified according to texture
- ***Foliated*** metamorphic rocks have mineral grains within the rock that are arranged in nearly parallel layers. Examples: ***slate***, ***schist***, and ***gneiss***.
- ***Non-foliated*** metamorphic rocks have mineral grains that change, grow and rearrange but don't form parallel layers. Examples: ***quartzite***, ***marble***.

Key Vocabulary: basalt, cementation, clastic, coal, compaction, convergent, cooling, divergent, extrusive, foliated, fossil, gneiss, granite, gypsum, harden, heat, igneous, intrusive, lava, limestone, magma, marble, metamorphic, minerals, non-clastic chemical, non-clastic organic, non-foliated, obsidian, pressure, pumice, quartzite, rock, rock salt, sandstone, sedimentary, schist, shale, slate, volcano, water

Part Five: The Rock Cycle

The ***rock cycle*** shows how the earth's rocks are changed again and again. The rocks can be changed at times to another type of rock. The rock cycle can begin anywhere in the cycle. Here's how it works…

- Igneous rocks start as magma. Technically, ALL rocks start as magma.
- The ***magma*** (molten rock under the surface) and ***lava*** (molten rock on the surface) cools and hardens into igneous rock.
- The igneous rock then breaks apart over time through the process of weathering.
- These bits of broken rock, called sediments, are washed away by rains (eosion) and deposited in a river.
- These pieces of igneous rocks are compacted and cemented together with other bits of rock and form a sedimentary rock called ***conglomerate***.
- Over time sedimentary rocks can be buried by earthquakes or other geologic processes.
- Being buried deep under the surface in areas of high ***temperatures*** and pressures or coming in contact with magma can cause these sedimentary rocks to change to metamorphic rocks.
- Metamorphic, sedimentary or igneous rocks can be remelted to form magma, beginning at the beginning again.

Rocks are changed by processes such as…

- weathering and erosion (and deposition) to form sediments
  - ***Weathering*** is the process that breaks rocks into smaller pieces called sediments.
  - ***Erosion*** is the movement of weathered materials to new locations, where they are then deposited.
  - ***Deposition*** is the laying down of rock forming material from any natural process.
  - ***Sediments*** are small pieces of loose materials such as rock fragments, mineral grains, and bits of plant and animal remains.
- compaction and cementation
  - ***Compaction*** occurs when small sediments stick together to form solid rock.
  - ***Cementation*** occurs when large sediments are glued together by minerals deposited between the sediments.
- ***melting*** – when rocks are buried deep enough to be melted back into magma
- ***cooling*** and ***hardening*** – allows crystals to form
- ***heat*** and ***pressure*** – when existing rocks are buried deep and are heated by a nearby source of magma

Key Vocabulary: cementation, compaction, conglomerate, cooling, deposition, erosion, hardening, heat, lava, magma, melting, pressure, rock cycle, sediment, temperature, weathering

Sample SOL Questions

1. **Metamorphic rocks with a layered or banded look are called —**

   A foliated **B** unfoliated **C** striated **D** evaporated

2. **Cyanite (Al^2SiO^5), quartz (SiO^2), and leucite ($KAlSi^2O^6$) may be grouped together because they all contain —**

   F aluminum **G** carbon **H** potassium **J** silicon

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

3. **The chart shows the Mohs scale for measuring the hardness of minerals. A mineral that can scratch fluorite and can be scratched by orthoclase is able to —**

   A scratch both calcite and quartz
   B be scratched by both calcite and quartz
   C scratch calcite and be scratched by quartz
   D scratch quartz and be scratched by calcite

4. **When granite is subjected to high enough amounts of heat and pressure to change it but not melt it, granite changes into —**

   A a metamorphic rock **B** a sedimentary rock **C** sediments **D** an igneous rock

Igneous Rocks

Type of Magma/Lava	Intrusive	Extrusive
Basaltic	Gabbro	Basalt, scoria
Andesitic	Diorite	Andesite
Granitic	Granite	Rhyolite, pumice, obsidian

5. **Of these igneous rocks, which would contain the *largest* crystals?**

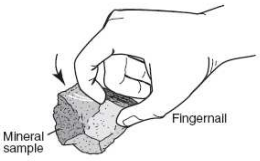
   A Granite **C** Pumice
   B Obsidian **D** Rhyolite

6. **The rock shown is composed primarily of large crystals that were formed by —**

   A cooling magma
   B compacting shells
   C weathering
   D faulting

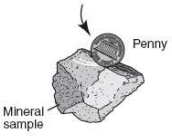
Igneous Rock

Testing a Mineral



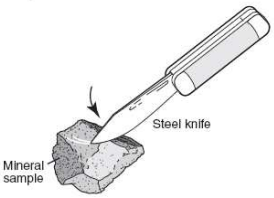
7. **The diagram on the right shows a test for which mineral property?**

   A Hardness **B** Cleavage **C** Luster **D** Streak



8. **Which of these can determine the size of grains in igneous rocks?**

   F Amount of rare minerals **H** Size of the volcano
   G Distance from a plate boundary **J** Cooling rate of molten rock



9. **The density of a mineral is determined by its mass and —**

   A hardness **B** luster **C** volume **D** shape

Application

One the following page, you will find diagrams to label, information to be completed or questions to be answered. Please complete the page accurately and study the information contained there.

Mineral Characteristics: (5 things)

1. _____
2. _____
3. _____
4. _____
5. _____

Mineral Tests for Identification:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Key Mineral Examples:

Rock Forming Minerals (4) _____

_____

Ore Forming Minerals (6) _____

_____

_____

Minerals with Special Properties:

Mica – _____

Sulfur – _____

Magnetite – _____

Galena – _____

Talc – _____

Halite – _____

Calcite – _____

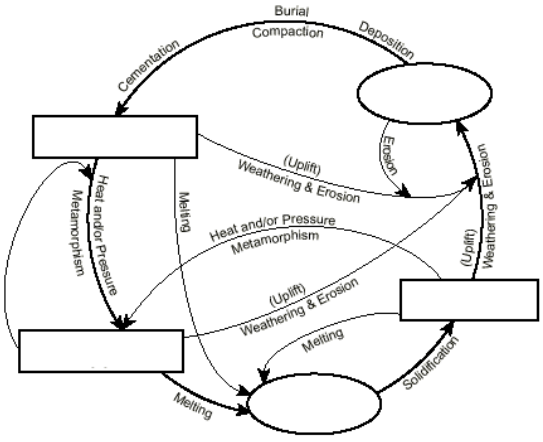
Graphite – _____

Moh's Hardness Scale: Complete the table.

#	Mineral	Can be scratched by a…
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Rocks and the Rock Cycle: Complete the table below. Using this information, complete the rock cycle by placing the appropriate letter in the box or oval in the diagram.

Rock Type & Info	Process of Formation	Sub-types & Characteristics	Examples
Igneous			
Sedimentary			
Metamorphic			



Rocks:

A – _____

B – _____

C – _____

Intermediate Materials:

D – _____

E – _____

Resources

(ES. 7 a-e, 12 e)

ES.7 The student will investigate and understand the differences between renewable and nonrenewable resources. Key concepts include:

- ☐ a) fossil fuels, minerals, rocks, water, and vegetation;
- ☐ b) advantages and disadvantages of various energy sources;
- ☐ c) resources found in Virginia;
- ☐ d) making informed judgments related to resource use and its effects on Earth systems;
- ☐ e) environmental costs and benefits.

ES.12 The student will investigate and understand the origin and evolution of the atmosphere and the interrelationship of geologic processes, biologic processes, and human activities on its composition and dynamics. Key concepts include:

- ☐ e) potential atmospheric compositional changes due to human, biologic, and geologic activity.

Essential Questions

You should be able to answer the following question with confidence about this topic.

- ☐ Natural resources are limited and can be classified as renewable or nonrenewable. Explain the difference between renewable and nonrenewable resources.
- ☐ A variety of natural resources can be found in Virginia. Summarize the ways that the physical characteristics of Virginia determine the type of natural resources.
- ☐ Overuse of resources can have negative environmental impact. Analyze how the environment is impacted by our use of resources.

Part One: Renewable and Nonrenewable Resources

Renewable resources…

- can be replaced by nature at a rate close to the rate at which they are used
- includes vegetation, water, and soil

Nonrenewable resources…

- are renewed very slowly or not at all (We use it faster than it can be replaced.)
- includes coal, oil, natural gas and minerals

Common misconception – Renewable does *not* mean recyclable. **Recycle** means to reuse.

Key Vocabulary: non-renewable, renewable, recycle

Part Two: Environmental Impacts of Energy Resources

Fossil Fuels, such as coal, oil and gas, are derived from prehistoric plant and animal material that had decomposed and been altered by heat and pressure over the years.

- Advantage: A quick, easy source of energy that does not cost that much.
- Disadvantages: Causes pollutions in many ways – burning fossil fuels produces CO_2, sulfur and nitrogen gases. Oil spills cause much damage to the plants and animals in the surrounding environment. We are running out of fossil fuels!
- Atmospheric Effects: Releases gases into the atmosphere- creating smog, acid rain, etc.

Coal, Natural Gas and Petroleum (Oil) are composed mostly of hydrogen and carbon. The hydrocarbons with a lower molecular weight are usually gasses. The heavier ones tend to be the oils. Once again, oil and gas are created much like coal is. Unfortunately, gas and oil are both Non-renewable resources.

Nuclear energy is an alternate energy source produced from atomic reactions (the splitting of atoms and the releasing of energy – Fission).

- Advantage: It is an alternate source of energy – when fossil fuels are being used up – we can turn to nuclear. It releases no harmful gases into the atmosphere. (ex. No CO_2, No Sulfur, No Nitrogen – thus – No Acid Rain).
- Disadvantages: The waste material produced – Nuclear Waste. It is high radioactive. Hard to find places to store it. Have very long half lives – can stay radioactive for 10,000 years.
- Atmospheric Effects: Normal operation of Nuclear Power Plants keeps radiation exposure to the surrounding environment at a minimum; however, a problem at the plant, such as a melt down, could release radiation into the environment and into the atmosphere.

Solar Energy refers to the energy the earth receives from the sun in the form of Solar Radiation. Devices called solar panels are placed facing the sun in order to capture solar radiation. The light energy is then converted into electrical energy.

- Advantages: It is a clean source of energy. No pollutants or harmful radiation.
- Disadvantages: The cost of setting up a home or business with solar panels. The problems with cloudy days – or multiple cloudy days.
- Atmospheric Effects: None.

Geothermal Energy uses the heat from magma inside the Earth to heat water and produce steam in a power plant. The steam is pressurized and then spins turbines that run generators to make electricity.

- Advantages: The Geothermal Plants are very reliable and clean. They are not radioactive. They do not produce pollutants. There is no threat of any lethal substances being spilled into the environment – such as oil, wastes.
- Disadvantages: It is not as convenient as fossil fuels. So far, it is not being used world wide. In order to reach the reservoirs, it is necessary to drill into the Earth.
- Atmospheric Effects: None.

Hydroelectric Energy involves the use of a dam to hold water on one side has generators at the base of the dam that converts the energy of the fast flowing water into electricity.

- Advantages: It is a renewable resource. The water can be used over and over. It is a clean source of electricity – no radiation, no wastes.
- Disadvantages: Could cause flooding of surrounding areas. It costs a lot of money to build a dam.
- Atmospheric Effects: None.

Wind Energy involves the use of machines called Aerogenerators (more commonly windmills). These are built to convert wind energy into electricity. The wind turns the rotor blades and these power generators.

- Advantages: It is a clean source of power.
- Disadvantages: The wind is un-predictable. Wind velocity that is too slow produces no electricity. Wind that is too fast can damage the machine. It costs a lot too develop and built the machines. There are problems in transporting electricity to sites where it is needed.
- Atmospheric Effects: None.

Tidal Energy involves placing generators in water and allowing the movement of the tides (flowing in and out) to power the generators thus producing electricity.

- Advantages: A clean source of energy. No pollutants, no radiation, no chemicals. Tidal energy is an endless supply of energy.
- Disadvantages: Constructing such machines is very expensive. Wave energy varies greatly with the weather. It would be difficult to build a device big enough in the water to convert the amount of energy in a wave to electricity. A device would be so big, that it would be dangerous to ships.
- Atmospheric Effects: None

Key Vocabulary: alternative fuel, energy, geothermal energy, hydroelectric energy, nuclear energy, ozone layer, solar energy, wind energy

Part Three: Virginia Resources

Coal is Virginia's most valuable *resource*. It is a *fossil fuel* and is a *non-renewable resource*.

- Virginia ranks among the top ten coal producing states in the U.S.
- Coal originates from ancient plants that flourished in swamp like environments millions of years ago. This material, called ***peat***, was buried over time and heat and chemical processes turned it into coal. Peat is not a rock.
- The first stage of coal production where it is considered a sedimentary rock is called ***lignite***. It is soft, burns fast and has low heat output.
- The next state is called ***bituminous coal***. It is a sedimentary rock. About 78% of the world's coal is this type.
- Under further heat and pressure, it turns into ***anthracite coal***..a metamorphic rock. It burns very slowly and has a high heat output. It is the most efficient and the most desirable.

Other Virginia resources include…

- limestone for building materials, sand & gravel for construction
- kyanite, a mineral used in electronic products
- uranium, a radioactive element used for nuclear energy production

Key Vocabulary: anthracite, bituminous, coal, fossil fuel, lignite, non-renewable resource, peat, resource

Sample SOL Questions

1. Which of the following is a renewable source of energy?

F Natural gas **G** Coal **H** Oil **J** Falling water

2. One method of lessening the environmental impact of strip mining is to —

A mine only nontoxic materials
B only mine during the evening hours
C feed the animals displaced by the mine
D requires landscape and vegetation of mined lands be restored

3. Limestone is a valuable resource in Virginia because limestone can be processed to make —

F plastic **G** steel **H** concrete **J** plywood

4. The fossil fuel found in *greatest* abundance in Virginia is —

A oil **B** coal **C** natural gas **D** methane

5. Some fuels are classified as nonrenewable because they —

A produce toxic waste
B can be easily recycled
C come from deep within Earth
D require a long period of time to form

6. The major disadvantage of using solar panels to generate electricity is that solar panels —

F release toxic fumes into the air
G cannot convert energy efficiently
H are affected by cloud coverage and day length
J produce energy that cannot be stored

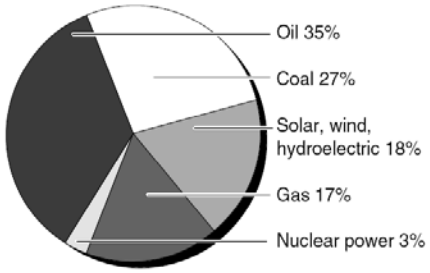

Solar Panels

7. Which of these energy sources has the */least* harmful environmental effects?

F Nuclear
G Fossil Fuels
H Solar
J Hydroelectric

8. The pie chart on the right shows different sources of energy. Which conclusion can be made based on this chart?

F Coal is the main source of energy.
G Use of nuclear power is increasing.
H Fossil fuels make up over three-quarters of our energy consumption.
J Renewable energy sources are predominantly used



9. Wind power is not typically used to generate all of the electricity needed for large cities because the —

A energy source is inconsistent
B waste products are unsafe
C fuel expenses are too great
D energy produced is not in a usable form

10. A major problem with depending on fossil fuels as primary energy sources is that they are —

A overabundant
B nonpolluting
C nonrenewable
D deep underground

Application

One the following page, you will find diagrams to label, information to be completed or questions to be answered. Please complete the page accurately and study the information contained there.

Renewable resources – _____

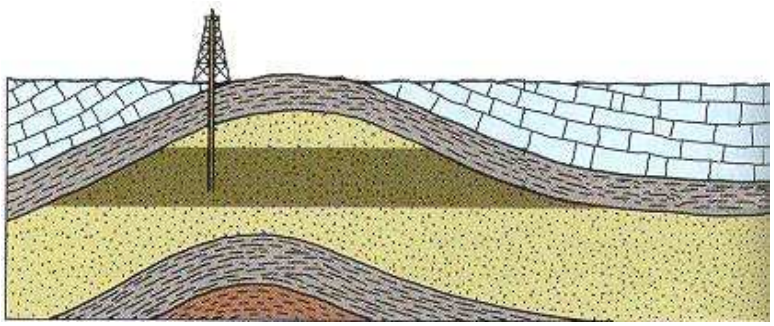
_____

Non-renewable resources – _____

_____

Fossil Fuels: Identify the regions in the diagram below. Use the key to help you locate them. Color as needed. Also, add labels to the diagram for the other two terms listed.

___ gas filled sandstone	___ impermeable rock
___ oil filled sandstone	___ impermeable shale
___ water filled sandstone	___ permeable limestone
oil well	cap rock



Fossil Fuel Advantage: _____

Fossil Fuel Disadvantage: _____

Fossil Fuel Types: (define)

Coal - _____

_____

_____

Oil - _____

_____

_____

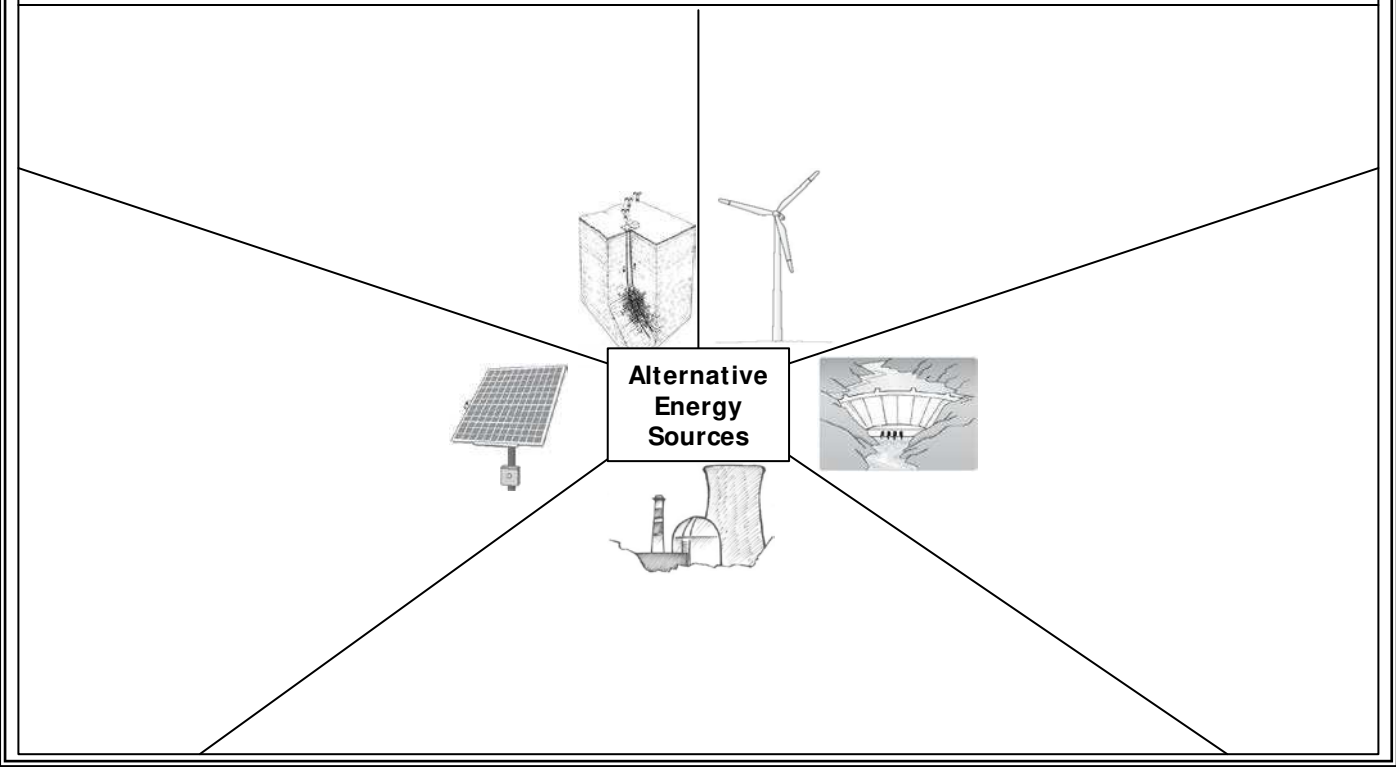
_____

Natural Gas – _____

_____

_____

Identify each form alternative energy source represented by the pictures below. Briefly define each and list at least one advantage and one disadvantage of using each.



Geologic Processes and Features

(ES. 1e, 2e, 8 b-c, 11d, 12e)

ES.1e The student will plan and conduct investigations in which:

☐ e) a scientific viewpoint is constructed and defended (the nature of science).

ES.2e The student will demonstrate scientific reasoning and logic by:

☐ evaluating evidence for scientific theories.

ES.8b,c The student will investigate and understand geologic processes including plate tectonics. Key concepts include:

☐ b) how geologic processes are evidenced in the physiographic provinces of Virginia including the Coastal Plain, Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau;.

☐ c) tectonic processes (subduction, rifting and sea floor spreading, and continental collision).

ES.11d The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include:

☐ d) features of the sea floor (continental margins, trenches, mid-ocean ridges, and abyssal plains) reflect tectonic processes;

ES.12e The student will investigate and understand the origin and evolution of the atmosphere and the interrelationship of geologic processes, biologic processes, and human activities on its composition and dynamics. Key concepts include:

☐ e) potential atmospheric compositional changes due to human, biologic, and geologic activity.

Essential Questions

You should be able to answer the following question with confidence about this topic.

☐ Earth's lithosphere and asthenosphere change constantly. How does the movement of material in the asthenosphere affect the lithosphere?

☐ Evidence from seismic waves provides information about earth's composition. How does evidence from seismic waves provide information about earth's composition?

☐ Plate tectonics causes changes in the earth's surface. How do plate tectonics change the earth's surface?

Part One: Earth's Composition

The Earth is composed of four different layers. Many geologists believe that as the Earth cooled the heavier, denser materials sank to the center and the lighter materials rose to the top. These four layers are...

- The ***crust*** is the outer layer of the Earth and is made of the lightest materials (rock- basalts and granites). The crust is the layer that you live on, and it is the most widely studied and understood. It is cool and brittle (rocky).
- The ***mantle*** is much hotter and has the ability to flow. It is the largest/thickest layer. The mantle is composed of very hot, dense, flowing rock. The material in the mantle flows because of convection currents. This causes the brittle crust to move as it floats on top of the mantle. It is like a warm plastic. It is also made up of two parts...the ***lithosphere*** (which is the top portion of the mantle as well as the crust) and the ***asthenosphere*** (which is the lower part of the mantle that has the convection currents).
- The ***outer core*** is even hotter, consists of heavy metals (nickel and iron) and is liquid.
- The ***inner core*** is hotter still with pressures so great that the heavy metals it is made of (nickel and iron) that they are in a solid state in spite of having the hottest temperatures.

There are two types of crust material...

- The ***continental crust*** is thicker but lighter. It is made up of mostly ***granite*** which is less dense.
- The ***oceanic crust*** is thinner but heavier. It is made up of mostly ***basalt*** which is more dense.

Convection currents are a circular current caused by the difference in temperatures from the bottom to the top of the mantle. It is because of these currents that the plates of the Earth have moved in the past and are moving today. These plate movements cause earthquakes, mountain building, and volcanism.

Key Vocabulary: asthenosphere, basalt, continental crust, convection, crust, granite, inner core, lithosphere, mantle, oceanic crust, outer core

Part Two: Plate Tectonic Processes and Landforms

The Earth's crust is broken into many pieces. These pieces are called plates. The movement of these plates is called ***plate tectonics***.

- There are twelve main plates on the Earth's surface.

- The Earth's plates are in constant, but very, very slow motion. They move at only 1/2 to 4 inches (1.3 to 10 centimeters) per year!
- The ***Continental Drift*** Theory states that the continents have moved and are still moving today.
- In 1912 Alfred Wegener introduced this theory, but he did not fully understand what caused the plates to move.
- Scientists believe that 250 millions years ago the Earth's seven continents were all grouped together into a super continent called ***Pangaea***.
- Scientists have used ***magnetic*** bands in rocks to prove that the continents have drifted apart. This also explains why fossils of tropical plants and animals that have been found in places like Antarctica and Greenland, and why fossils of fish found in high mountain regions.

A plate boundary occurs where two plates come together. There are three kinds of plate boundaries.

- A ***convergent*** boundary is where two plates collide to form mountains or one plate riding above the other driving the thinner denser plate down into the mantle creating a ***subduction*** zone. ***Trenches*** form at subduction zones. They are the deepest part of the oceans and the lowest points on the crust of the Earth. Subduction zones are areas of the world in which high amounts of earthquakes and volcanoes are present. There are 3 types of convergent boundaries, all of which are the result of ***compression*** forces (pressing together).
  - ocean-to-ocean, where 2 oceanic plates collide, forming a subduction zone, a trench and a volcanic ***island arc*** chain (example: Aleutian Island Arc Chain, Alaska and the Japanese Island Arc Chain)
  - ocean-to-continent, where an oceanic plate collides with a continental plate, forming a subduction zone, a trench and ***continental volcanic arc*** (example: Andes Mountains of South America)
  - continent-to-continent, where 2 continental plates collide forming ***folded*** and ***faulted*** mountains with <u>no volcanoes</u> (example: Appalachian Mountains and Himalayan Mountains)
- A ***divergent*** boundary is where two plates are moving in opposite directions. Divergent boundaries cause the oceans to spread apart (as a result of ***tension*** force, pulling apart) while convergent boundaries cause the oceans to shrink. There are two types of divergent boundaries.
  - ***seafloor spreading*** is where two oceanic plates are moving apart and a ***mid-ocean ridge*** is formed. As they spread apart magma fills the void causing the formation of new crust. This separating is called ***rifting***. In the middle of the mid-ocean ridge is a rift valley (example: Mid-Atlantic Ridge).
  - a ***rift valley*** can also be the result of two continental plates moving apart. It is the same as seafloor spreading except that it occurs on land (example: The Great African Rift Valley).
- A ***transform*** boundary is where two plates are sliding past each other by a force called ***shearing***. Transform boundaries are like tears in the Earth's crust. An example is the San Andreas Fault. This boundary type has <u>no volcanoes</u>.

<u>Key Vocabulary</u>: compression, continental drift, continental volcanic arc, convergent, divergent, faulting, folding, island arc, magnetic, mid-ocean ridge, Pangaea, plate tectonics, rifting, rift valley, seafloor spreading, shearing, subduction, tension, transform, trench

Part Three: Mountains

The movement of tectonic plates is responsible for the formation of mountains**.**

- ***Folded*** mountains are a wave-like formation. Continental plates are pushed together and form tall mountains.
- ***Fault-block*** mountains occur when the plates are pushed together and break from the collision. These mountains have very rough linear peaks. If one fault is present, it forms a tilted mountain. If two faults are present a lifted mountain is formed.
- ***Dome*** mountains form when plate collisions push an area of the crust up into a dome shape. The crust doesn't snap and break as in fault-block mountains.

<u>Key Vocabulary</u>: dome, fault-block, folded

Part Four: Earthquakes and Faults

Earthquake activity is associated with <u>all</u> plate boundaries because those plates are in motion. The plates do not move smoothly and evenly.

- Great ***stresses*** build up along the plate boundaries.
- An earthquake is a shaking of Earth's crust caused by a release of ***energy***.
- When a plate moves suddenly a great amount of energy is released in the form of ***wave*** energy. These waves are what cause the damage from an earthquake.

- The *focus* is the point in Earth's interior where energy is released. This is where the first movement occurs.
- The *epicenter* is the point at the surface above the focus.

Seismic Waves are the energy waves that move outward from the earthquake focus and make the ground quake. There are three types of seismic waves.

- *Primary* waves (*P* wave) move through Earth and cause particles in rocks to move in a push-pull motion. The force involved is *compression*.
- *Secondary* waves (*S* wave) move through Earth, causing particles to move side to side at right angles to the direction of the wave. The force involved is *shearing*.
- *Surface* or *Long* waves (*L* wave) move on the surface giving particles an elliptical and more rolling motion. When P and S waves reach the surface, they set up the L wave. The force involved is *tension*.

Magnitude is the measure of the strength of the seismic waves that have been sent out from the focus.

- A *seismograph* is an instrument that records the length and severity of an earthquake on a *seismogram*. The P- and S-wave information from 3 geographic locations is required to determine the actual location of an earthquake.
- The *Richter* scale is used to measure the strength of an earthquake. The scale ranges from a low of 1 to a high of 10.
- The *Mercalli* scale measures severity of damage of earthquakes that occurred before the invention of the seismograph. This scale ranges from a low of I to a high of XII.

A *fault* is a break or crack in the Earth's surface along which movement has occurred. On either side of most faults is a *hanging* wall (the rock above the fault) and a *foot* wall (the rock below the fault). There are 4 basic types of faults.

- A *normal* fault is caused by the force of tension when rocks pull apart (divergent plates).
- A *reverse* fault is caused by forces of compression when rocks are pushed together (convergent plates).
- A *thrust* fault is like a reverse fault that is not only pushed together but where the hanging wall is pushed over and on top of the foot wall.
- *Strike-slip* Faults are caused by shearing forces when rocks slide past each other.

Key Vocabulary: compression, earthquake, energy, epicenter, fault, focus, foot, hanging, L, long, Mercalli, normal, P, primary, reverse, Richter, S, secondary, seismic waves, seismogram, seismograph, shearing, stress, strike-slip, surface, tension, thrust, wave

Part Five: Volcanoes

The motion of the Earth's plates help scientists to understand why volcanoes occur. Volcanoes are openings in the earth's surface where magma is released as lava. *Magma* is molten rock that is under the Earth's crust. *Lava* is molten rock that that reaches the Earth's surface.

- Active volcanoes spew *smoke*, *steam*, *ash*, cinder, lava.
- Volcanoes occur at: divergent boundaries, convergent boundaries, and hot spots.
- The *crater* is depression at top of cone.
- The *cone* is the body of the volcano.
- The *vent* is the opening in crater where lava flows.
- The *magma chamber* is the reservoir of magma underground beneath the volcano.
- The volcanic *neck* forms when a dormant volcano has magma hardened in the vent and over many years the cone erodes away leaving this igneous column behind.
- A *caldera* forms when the top of the volcano collapses into magma chamber, creating a deeper depression, sometimes forming a crater lake.

Volcanoes are classified by the eruption type, magma type and by the volcanic cone shape.

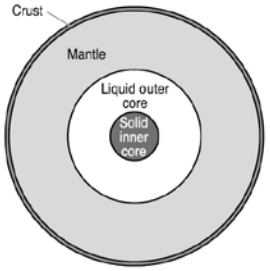
- *Shield* volcanoes were named by Icelandic people because the shape reminded them of a warriors shield laid down. Shield volcanoes form from hot, runny lava that is erupted from the volcano through its summit and the many side vents and fissures throughout the volcano's flanks (sides). Shield volcanoes are low, very broad, and gently sloping. Shield volcanoes have quiet eruptions. *Hot spot* volcanoes are shield volcanoes. They form because of a weak spot in the crust rather than from plate boundary action.
- *Cinder* cones get their name from the material that forms them, cinders. Cinder cones are the simplest volcanic formation. They form from explosions of red, hot magma cinders and ash. These cinders and ash settle around the main vent and build a steep sided cone. Very little lava is erupted from a cinder cone. Cinder cones very rarely rise to more than 1,000 feet above the surrounding landscape. Cinder cones are known for their very violent, explosive, exciting eruptions.

- *Composite* cones are formed from a combination of eruptions. Composite volcanoes have quiet eruptions with easy flowing lava and violent eruptions with explosives tephra (lava that has hardened and broken into various size pieces, the debris thrown from volcanoes) layers made of alternating lava and tephra pieces. A large composite cone will be built with many layers of ash and lava. Composite cones are the most common type of volcanic cone.

Key Vocabulary: ash, caldera, cinder cone, composite, cone, crater, hot spot, lava, magma, magma chamber, neck, shield, smoke, steam, vent

Sample SOL Questions

1. Even though the Earth's inner core is hotter than the liquid outer core, it is still solid because —

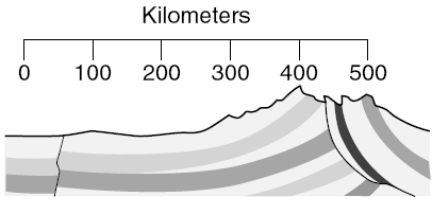


A the heat rising from the inner core is melting the outer core
B there is more water in the outer core and it dilutes the materials
C the outer core is farther from the center, and there is less gravity holding it together
D the pressure from all of Earth's layers keeps it in a solid state

2. All of the following support the theory of continental drift *except* that —

F the continents seem to fit together like pieces of a puzzle
G there are similar fossils on different continents
H mountain ranges in South America and Africa line up
J the North Pole and Antarctica are covered with ice

3. The mountain shown is composed of deformed sedimentary layers. They are located near a tectonic plate boundary and are still increasing in elevation due to —



A colliding tectonic plates
B seafloor spreading of tectonic plates
C subduction of a tectonic plate
D transform faulting of a tectonic plate

4. Which of the following is *not* considered a result of the movement of tectonic plates?

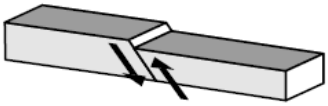
F Earthquakes
G Mountain ranges
H Increased volcanic activity
J Karst topography

5. Geologists think that parts of the Appalachian Mountains formed originally from sediments accumulating in shallow swamps. The weight of the sediments caused the area beneath them to sink, allowing more sediments to accumulate. The process continued until many layers had formed. Then tectonic processes folded the layered sediments into a range of mountains. What evidence for this theory can be found in the current structure of these mountains?

A Some rocks making up these mountains show signs of volcanism.
B The form of these mountains is very eroded.
C The mountains exhibit folded layers of rocks containing fossils from shallow water.
D The mountain range consists of parallel ridges of different ages

6. Which provides the best evidence for the theory that faults and volcanoes are results of tectonic plate interactions?

F Faults on tectonic plates are in constant motion, but volcanoes may not erupt for many years.
G Faults and volcanoes existed long before there were tectonic plates.
H Tectonic plates that have many faults do not usually have volcanoes.
J Faults and volcanoes are often found at tectonic plate boundaries.



7. The diagram shown illustrates which geological process?

A Faulting **B** Folding **C** Weathering **D** Metamorphism

8. When the sea floor spreads apart, volcanoes and ridges are formed because —

A sediments are deposited where the floor spreads, building ridges
B as the plates pull apart, magma moves to the surface, building ridges
C ocean water pushes down on the surrounding sea floor, pushing up ridges
D underwater earthquakes lift the sea floor into long ridges

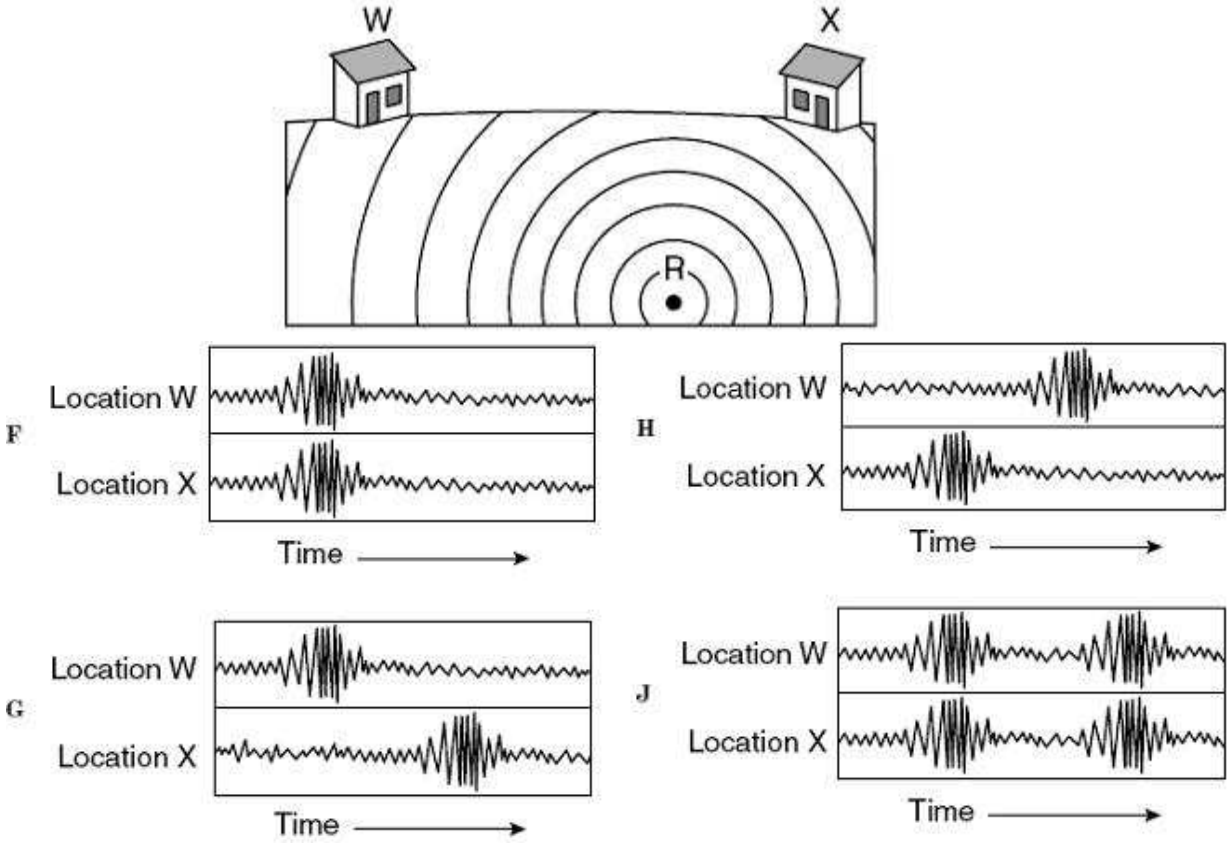
9. The Earth's mantle is made up of very hot material that rises to the top of the mantle, cools, then sinks, reheats, and rises again, constantly repeating the cycle. This action, which causes the Earth's crust to move, is known as —

A convection currents **B** magnetic fields **C** hot spots **D** advection forces

10. One part of California is on the Pacific Plate, while the remainder of the state is on the North American Plate. The two plates are moving to the northwest at different speeds, causing one plate to slide past the other. This movement in plates creates a —

A normal fault **B** reverse fault **C** strike-slip fault **D** thrust fault

11. Seismic waves generated by an earthquake at point R are recorded at locations W and X. Which pair of seismographs is more accurate?



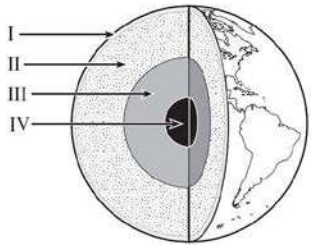
12. Compared to the Rocky Mountains, the Appalachian Mountains are much —

A older **B** less eroded **C** higher **D** thicker

Application

One the following pages, you will find diagrams to label, information to be completed or questions to be answered. Please complete the pages accurately and study the information contained there.

Layers of the Earth: Label and define the layers shown.



I. _____ – _____

_____

II. _____ – _____

_____

III. _____ – _____

_____

IV. _____ – _____

_____

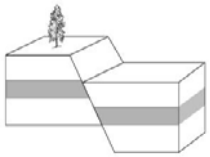
4 Evidences for Continental Drift Theory:

1. _____
2. _____
3. _____
4. _____

Faults: Identify each type of fault shown. Label the hanging wall and the foot wall. Identify the force for each. Show the direction that the rock moves on each side of the fault line.

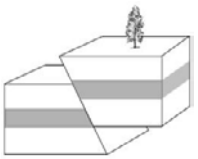
_____ Fault

Force: _____



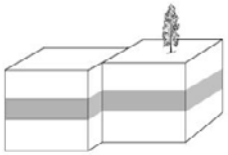
_____ Fault

Force: _____



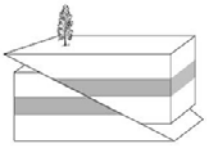
_____ Fault

Force: _____

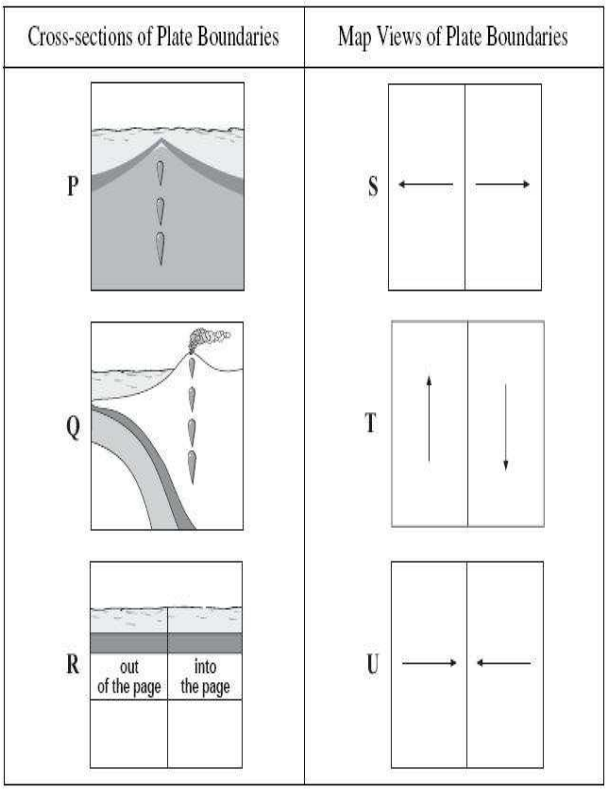


_____ Fault

Force: _____



Boundary Types: Identify the 3 boundary types shown and provide the requested information. Also, in the diagrams below, match the cross-section with the map view of the plate boundaries.



Transform Boundary: ____ & ____.

Plates move _____.

The force is _____.

An example is _____.

Divergent Boundary: ____ & ____.

Plates move _____.

The force is _____.

One type is: _____.

Example: _____.

Second type is: _____.

Example: _____.

Convergent Boundary: ____ & ____.

Plates move _____.

The force is _____.

One type is: _____.

Example: _____.

Second type is: _____.

Example: _____.

Third type is: _____.

Example: _____.

Earthquake Terms: Define the terms below. Also, identify the term that matches the letter in the diagram.

Seismo – _____

Seismology – _____

Seismologist – _____

Seismograph – _____

Seismogram – _____

Richter Scale – _____

Mercalli Scale – _____

Fault – _____

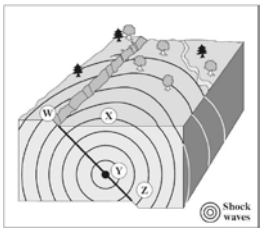
Focus – _____

Epicenter – _____

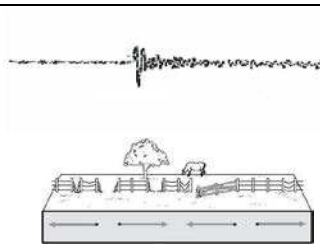
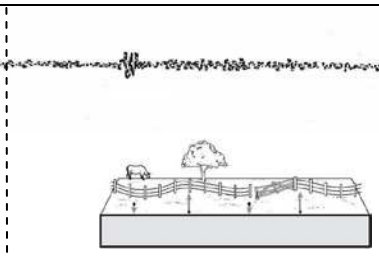
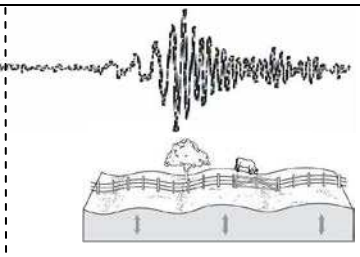
W – _____

X – _____

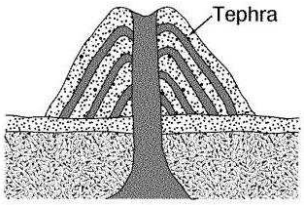
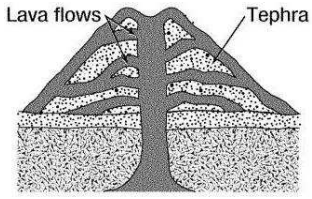
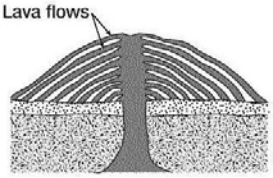
Z – _____



Seismic Waves: Complete the missing information for the table below.

Seismic Waves			
Wave Letter			
Wave Name			
Order of Arrival			
Motion			
Force			

Volcanoes: Complete the missing information for the table below.

Picture:			
Example:			
Type:			
Magma Type:			
Eruption Info:			
Slope Info:			
Where found:			

Freshwater Resources/ Geologic Processes

(ES. 8 b, 9a-e)

ES.8 The student will investigate and understand geologic processes including plate tectonics. Key concepts include:

- ☐ b) processes (faulting, folding, volcanism, metamorphism, weathering, erosion, deposition, and sedimentation) and their resulting features;

ES.9 The student will investigate and understand how freshwater resources are influenced by geologic processes and the activities of humans. Key concepts include:

- ☐ a) processes of soil development;
- ☐ b) development of karst topography;
- ☐ c) identification of groundwater zones including water table, zone of saturation, and zone of aeration;
- ☐ d) identification of other sources of fresh water including rivers, springs, and aquifers with reference to the hydrologic cycle;
- ☐ e) dependence on freshwater resources and the effects of human usage on water quality;

Essential Questions

You should be able to answer the following question with confidence about this topic.

- ☐ Weathering, erosion, and deposition processes change the surface of the earth and result in various landforms. Describe how do agents of erosion affect the earth's surface.
- ☐ Freshwater resources are influenced by geologic processes and the activities of humans. How is freshwater influenced by geologic processes?
- ☐ Explain the ways in which humans are dependent on freshwater.
- ☐ How do human activities impact freshwater resources?
- ☐ Earth undergoes regular patterns of change and natural cycles, both quickly and over time. How do geologic processes affect the flow of water underground?

Part One: Physical and Chemical Weathering

Weathering is the process in which rocks break down into smaller pieces. There are two methods by which this may occur. Each method has several types.

Mechanical weathering, also called physical weathering, is when rocks are broken down into smaller pieces by mechanical means (wind, water, or ice). It does not chemically change the rock in any way.

- ***Ice wedging*** is a type of mechanical weathering in which breaks in rock result from the freezing and thawing of water. It can also be called freeze/thaw or frost wedging.
- ***Abrasion*** is a type of mechanical weathering in which breaking up of rocks occurs from their collisions with other rock.
- ***Plant roots*** can cause weathering when the roots split rock material apart.
- ***Animal activity*** such as burrowing physically or mechanically alters rock material.
- ***Exfoliation*** occurs because of winds.
- ***Friction*** of water running across rocks can weather rocks.
- ***Temperature changes*** cause weathering due to the expansion and contraction of rock materials.

Chemical weathering, also called decomposition, is when rocks are broken down into smaller pieces by chemical action. Chemical weathering will occur when chemical reactions take place between the minerals in the rock & water, carbon dioxide, oxygen & acids.

- ***Hydrolysis*** occurs when minerals in rock react with water and the rock becomes less stable and is easily broken down into pieces.
- ***Carbonation*** occurs when CO_2 reacts with water to form carbonic acid (H_2CO_3). This acid speeds up hydrolysis to form caves and sinkholes.
- ***Oxidation*** occurs when metallic elements react with oxygen; usually found in Fe (iron) bearing minerals (form iron oxide or rust).
- ***Plants*** produce ***acids*** that seep into rock and produce cracks in the rock.

Key Vocabulary: abrasion, animal activity, carbonation, chemical weathering, exfoliation, friction, hydrolysis, ice wedging, mechanical weathering, oxidation, plant acids, plant roots, temperature changes, weathering

Part Two: Soil Formation

Soil is a mixture of minerals, water, gases and ***humus*** (decomposed or decomposing plant and animal material); capable of supporting plant growth. Soil development starts with the weathering of bedrock. ***Organic*** material (living or once living things) must be present in order to have soil. Residual soil is soil that has bedrock as its parent material. Transported soil is formed from parent material left by winds, rivers, or glaciers, or soil that has been moved from its original location. A layer of soil is a ***horizon*** and all of the horizons together form a ***soil profile***. Soil profile consists of three man horizons: A- ***topsoil*** (humus), B- subsoil- minerals leached from layer A(less humus), C- partially weathered bedrock. You may also see O- (organic layer) and ***parent rock*** (bedrock from which soil forms) included as horizons.

Key Vocabulary: horizon, humus, organic, parent rock, soil profile, topsoil

Part Three: Erosion and Mass Wasting

Erosion is the removal and transport of earth materials by natural agents. It results in ***deposition*** (the depositing or laying down) of sediments elsewhere.

- Common agents of soil erosion are gravity, glaciers, wind, and water.
- ***Mass wasting*** is the movement of eroded fragments down a slope by gravity. Slow mass movement (***creep***) is a slow, imperceptible downslope movement of the soil. Rapid movement (***landslide***) is the sudden movement of a mass of bedrock or loose rock. ***Slump*** is a rapid rotational movement where a portion of a hillside slips.

Water picks up speed and energy as it flows downhill due to gravity. ***Runoff*** is the water that does not soak into the ground or evaporate. Water from run-off travels along the ground, eventually emptying into streams, lakes or oceans. Some of the factors affecting runoff are:

- the amount of rain that falls
- the amount of vegetation on the land
- the time span over which it falls
- the ***slope*** of the land (steepness)

Key Vocabulary: creep, deposition, erosion, landslide, mass wasting, runoff, slope, slump

Part Four: River Mechanics and Deposition

Stream erosion forms a deep and wide channel carrying many sizes of sediments. A ***channel*** is the main part of the stream where the majority of the water flows. The stream bank is the part of the stream channel that is above water. The stream bed is the part of stream channel that is below the water. Streams are classified by their ages. Each age can be identified by landforms, the ***velocity***, or speed, of the water and its ***carrying ability*** (the amount and size of sediments that it transports). Rivers always carve out a ***v-shaped valley***.

- Young streams flow quickly through a valley and has steep sides. Large boulders can be moved by the fast moving water. This digs out the bottom of the water, deepening and widening the channel. This amount and size of sediment is called either ***bedload*** or ***traction***.
- Mature streams flow slower and starts to curve or meander through a valley. The velocity of the water in mature streams can not carry boulders. Large rocks can be bounced along the bottom. These bouncing rocks are called ***saltation***.
- Old Streams flow slowly through a wide, flat ***floodplain***. The smallest sediments are found in this water. These smaller sediments are either the ***suspended load*** (the sediments that suspended in the column of water) or the ***dissolved load*** (the dissolved material).

River water starts out in gullies & small streams; eventually these branching arms allow water to flow into a river. River systems consist of ***tributaries***, which are small streams that feed into rivers, the watershed, which is the land from which the water runs into the streams, and channel, which is the path that the stream follows. ***Stream piracy*** is where one tributary overcomes another and they join together.

- At the end of the river, sediments being carried by water are deposited.
- A ***delta*** forms when a river hits a larger body of water the velocity decreases dramatically and sediments will settle in a fan shape.
- An ***alluvial fan*** forms when sediments are deposited in a triangle shape at the base of a mountain stream.
- The drainage basin is the area of land where a stream gets it water.
- A ***meander*** is a curve in a stream.
- On the outside of the curve, the water moves fastest and cuts into the banks, forming a ***cut bank***. This is a feature caused by ***erosion***.
- On the inside of the curve, the water moves slower and drops heavier particles, forming a ***point bar***.

- The floodplain is the broad, flat valley floor that gets covered with water when a stream floor.
- An ***oxbow lake*** is a meander that has closed off forming a lake.

Key Vocabulary: alluvial fan, bedload, carrying ability, channel, delta, cut bank, dissolved load, erosion, floodplain, meander, oxbow lake, point bar, saltation, stream piracy, suspended load, traction, tributary, v-shaped valley, velocity

Part Five: Glaciers

A ***glacier*** is a 'river' of ice. There are two main types of glaciers. A ***valley glacier*** is one that is found in the valleys of mountainous areas. A ***continental glacier*** is one that is found covering large land masses like Antarctica. Glaciers dig out areas, breaking up and picking up the rock below and depositing it further down the glacier, acting like a bulldozer. Sometimes these pieces get pushed along the side of the glacier. Either one, at the end or along the sides, the debris forms a ***moraine***. Glaciers form ***u-shaped valleys***.

Key Vocabulary: continental glacier, glacier, moraine, u-shaped valley, valley glacier

Part Six: Karst Topography

Karst Topography refers to landforms made from dissolving ***limestone*** (a sedimentary rock commonly found in the Valley and Ridge Province of Virginia). Karst Topography is characterized by several features that are produced by acidic groundwater dissolving limestone.

- ***Caverns*** (caves) form from water that has dissolved limestone underground, leaving an opening.
- ***Sinkholes*** form when the roof of a cave collapses, leaving a hole or depression on the Earth's surface.
- ***Disappearing streams*** occur when streams drop into a sinkhole and continue to flow underground.
- ***Stalactites*** form when water drips from top and calcite solidifies. A mnemonic device for remembering this one is to remember the 'c' in stalactite means it is coming from the ceiling and it is holding 'tite' (tight).
- ***Stalagmites*** form when dissolved calcite deposits on the floor. A mnemonic device for remembering this one is to remember the 'g' in stalagmite means it is coming from the ground and reaching up with all its 'mite' (might).
- When a stalactite and a stalagmite join together it is referred to as a ***column.***

As groundwater passes through the bedrock, it dissolves minerals (usually calcium from ***calcite***). Hard water contains large amounts of dissolved minerals. Soft water contains few dissolved minerals.

Key Vocabulary: calcite, cavern, column, disappearing stream, karst, limestone, sinkhole, stalactite, stalagmite

Part Seven: Groundwater Zones and Sources of Freshwater

Seventy-five percent of the earth is covered by water. Ninety-seven percent of earth's water is salt water. Most of the fresh water is 'locked up' in the glaciers and ice caps. Less than 0.3% of all water is drinkable. Water is distributed on Earth by means of the ***hydrologic cycle***, also known as the water cycle. The components of the water cycle are:

- ***evaporation*** – when water is changed from a liquid to a gaseous state
- ***condensation*** – when water is changed from a gaseous state to a liquid state in the atmosphere causing clouds
- ***precipitation*** – when the liquid water is too heavy to remain in the clouds, falling to Earth in the form of rain, snow, sleet, hail, or freezing rain
- ***evapotranspiration*** – when moisture in a gaseous state is added to the atmosphere from trees, plants and animals
- ***runoff*** – where water that falls in the form of precipitation does not soak into the ground but moves on the surface in streams, rivers, lakes or oceans
- ***groundwater*** – water in a liquid state that moves under the surface of the Earth

It is found in surface water and in groundwater. ***Groundwater*** is water that seeps down into soil and fills in the spaces (pores) between soil particles. Porosity is the percentage of a material's volume that is pore space. ***Porosity*** describes the pore space in a material, but it does not describe whether water can pass through the material. Permeability is the rate at which water pass through the pore spaces of a rock. ***Permeable*** describes soil and rock that allows water to pass through it. ***Impermeable*** describes rock that water can not easily pass through.

Groundwater layers from the surface down would include zone of aeration, water table, and zone of saturation.

- Groundwater continues to soak deeper into the ground through permeable rock until it reaches a layer of impermeable rock – stopping it from moving further.
- The water backs up, filling the pores of the rock layer above the impermeable layer – this layer of ground where all pores are filled with water is the ***zone of saturation***.

- The upper layer of the zone of saturation is called the ***water table***.
- The ***zone of aeration*** is between the water table and Earth's surface.
- An ***aquifer*** is a body of rock through which water flows or is stored.

There are other features that are related to groundwater.

- Wells are drilled down to the zone of saturation. A pump must be used to bring water to the surface.
- An ***artesian well*** is a well in which water spouts out of an aquifer due to pressure from surrounding water, so no pump is necessary.
- Where water is removed faster than it can be replaced, a ***cone of depression*** forms.
- A ***spring*** is a natural flow of groundwater that flows to the earth's surface and flows out (source of freshwater); most are cold springs but some are hot.
- In a ***hot spring***, the water is heated by magma.
- ***Geysers*** are hot spring that erupts periodically due to high heat and pressure underground.

Key Vocabulary: aquifer, artesian well, condensation, cone of depression, evaporation, evapotranspiration, geyser, groundwater, hot spring, hydrologic cycle, impermeable, permeability, permeable, porosity, precipitation, spring, water table, zone of aeration, zone of saturation

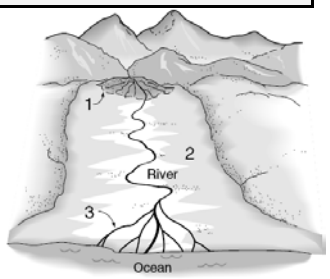
Part Eight: Human Usage on Water Quality

Waste from industry, fertilizers, pesticides, and salt from oceans will all pollute our groundwater. Water ***conservation*** describes measures set forth to conserve water. Examples include: trying to find other supplies of fresh water, ***desalination*** (removal of salt), discouraging excess use of water from table, and recycling used water.

Key Vocabulary: conservation, desalination

Sample SOL Questions

1. Which answer below matches the number in the drawing with the correct name of a sedimentary formation?

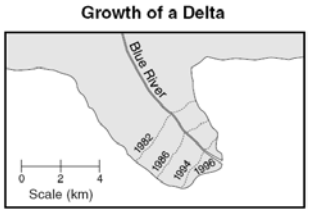


A 1-delta, 2-continental rise, 3-flood plain
B 1-alluvial fan, 2-flood plain, 3-delta
C 1-barrier island, 2-continental shelf, 3-alluvial fan
D 1-continental shelf, 2-continental rise, 3-barrier island

2. Which of these substances plays the *most* important part in chemical weathering?

F Wind **G** Water **H** Ice **J** Frost

3. By how much has the length of the delta increased from 1982 to 1996?

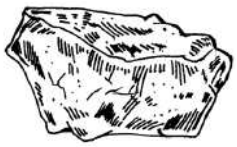


F 2 km **G** 4 km **H** 6 km **J** 8 km

4. What is located beneath soil layers?

A Bedrock **B** Humus **C** Lava **D** Tundra

5. Which of these pieces of basalt rock has probably been in a river the longest?

A 
B 
C 
D 

6. Dramatic variations in the polar ice caps and glaciers *most* likely suggest changes in —

A the Moon's orbit.
B Earth's climate.
C ebb and flow of tides.
D global water consumption.

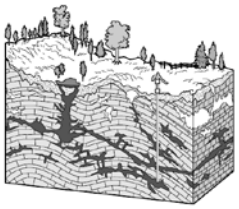
7. Sinkholes associated with natural processes are characteristic of what type of bedrock?

F Limestone **G** Granite **H** Basalt **J** Gneiss

8. Why does water move more slowly through clay than through humus?

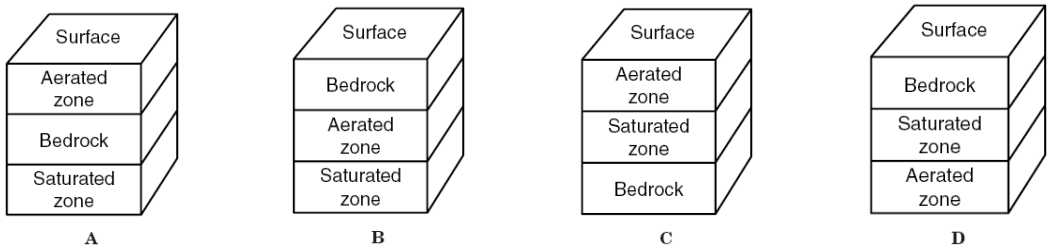
A Clay has greater permeability.
B Clay has very small pore spaces.
C Clay prevents capillary attraction of water.
D Clay reduces evaporation rates.

9. The picture on the right shows that one of the main pollution problems associated with sinkholes is that —



A they can destroy roadways
B tractors can fall into them
C homes can be damaged by them
D they can connect directly to the water table

10. Which diagram below best represents the most common arrangement of zones in a water table?



11. Oil spills have a tremendous impact on the ocean environment, and the oil must be cleaned up after these spills. A new technique for cleaning oil from beaches is called bioremediation. This technique uses naturally occurring bacteria to break down the oil. How is this accomplished?

A The bacteria bind with the oil and bring it to land.
B The bacteria pull the oil down to the ocean floor.
C The bacteria chemically change the oil into less harmful substances.
D The bacteria die and absorb the oil.

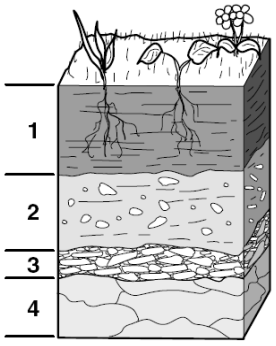
12. All of the following may be found deep in a natural cave EXCEPT —

A groundwater **B** mineral deposits **C** photosynthetic organisms **D** stalagmites

13. Which of these best describes forest soil?

F More rock fragments in the humus layer than in deeper layers
G More organic matter in the humus layer than in deeper layers
H More clay in the humus layer than in deeper layers
J More sand-sized particles in the humus layer than in deeper layers

14. Which layer of the soil profile on the right would be affected the most by weathering and erosion?



A 1 **B** 2 **C** 3 **D** 4

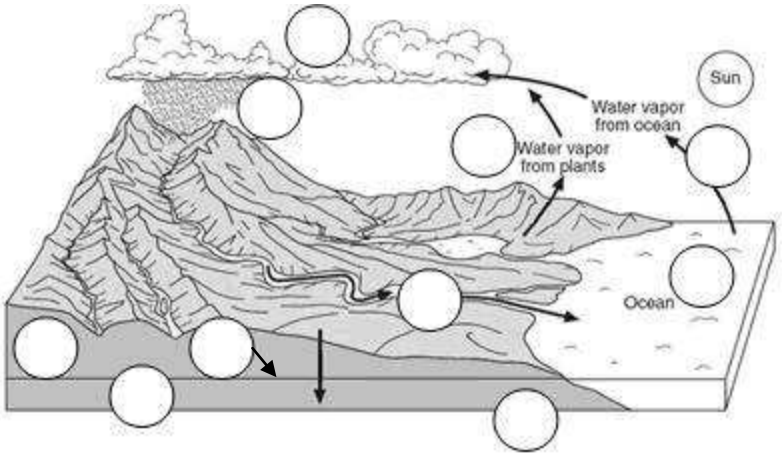
15. Organic matter in soil is made from —

F weathered parent rock
G decayed plants and animals
H acid rain
J carbon dioxide

Application

One the following pages, you will find diagrams to label, information to be completed or questions to be answered. Please complete the pages accurately and study the information contained there.

Groundwater and the Water Cycle: Use the number of the term listed below and label that item in the diagram. Then define the terms.



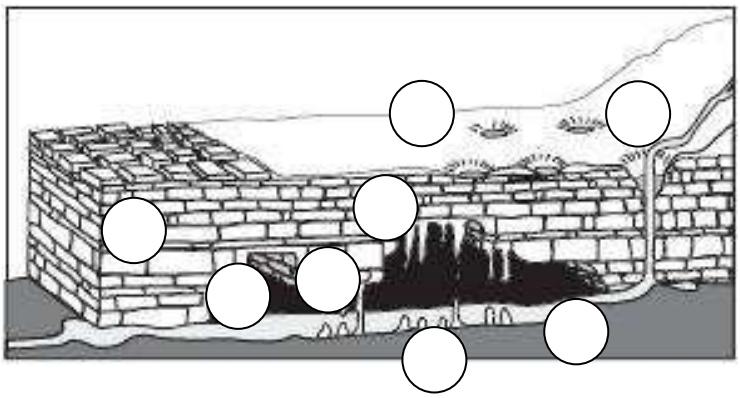
1. condensation – _____
2. evaporation – _____
3. evapotranspiration – _____
4. groundwater – _____
5. precipitation – _____
6. runoff – _____
7. surface water – _____
8. water table – _____
9. zone of aeration – _____
10. zone of saturation – _____

Weathering: List the two types of weathering define them and give examples of each.

_____ – _____

_____ – _____

1. cavern – _____
2. column – _____
3. disappearing stream – _____
4. limestone – _____
5. sinkhole – _____
6. stalactite – _____
7. stalagmite – _____
8. underground stream – _____



In Virginia, karst regions are found in the _____ province.

Define karst: _____

Briefly discuss the following human impacts to groundwater.

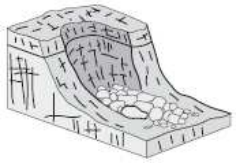
Burning fossil fuels – _____

Dumping of fertilizers, herbicides & pesticides – _____

Overuse of groundwater – _____

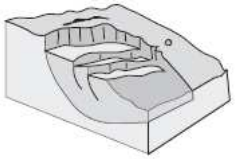
The 4 agents of erosion are _____, _____, _____, & _____.

Models of Mass Wasting: Identify the models below based on the description of each.



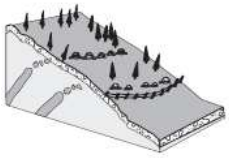
_____

- high velocity event
- material is loose
- material is dry
- results in talus



_____

- high velocity event
- material breaks off
- rotational
- creates scarps



_____

- very low velocity event
- caused by heating/cooling, freezing, thawing, wetting, drying

_____

- low velocity event
- material is connected (talus)
- wet, not saturated

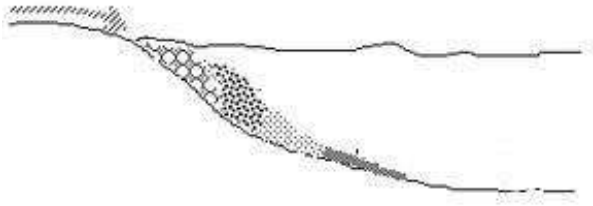
Carrying Capacity of Streams and Rivers: The diagram shows which particles drop out, in order, as stream velocity slows down. Identify the particles in the order in which they settle. Draw the symbol for that particle in the box to the left of the term you choose.

☐ _____ – largest particle size

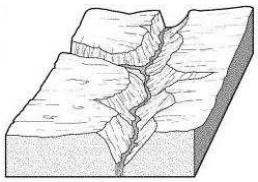
☐ _____ – 2nd to settle out

☐ _____ – 3rd to settle out

☐ _____ – last to settle out



Stages of River Development: Identify the river stages and give 3 facts about each stage. Facts should include the speed of the water, the size particles each can carry and any landforms associated with each.



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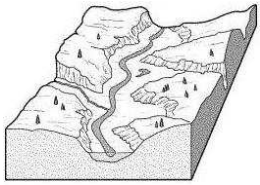

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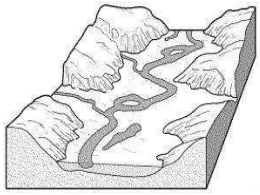

_____

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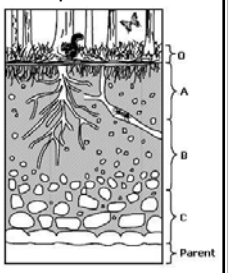
_____

Soil Profile: Briefly describe each layer in the space below the diagram.



O _____

_____

A _____

_____

B _____

_____

C _____

_____

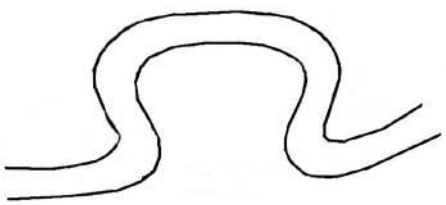
Parent _____

_____

Another name for a soil layer is a soil _____.

Together they make a _____.

Oxbows and River Turns: Indicate the areas of deposition (4) and erosion (4) on the diagram below. Show how the oxbow will form. Indicate the location of the channel of the stream as it travels through the cut banks and point bars.



Topic 7: Historical Geology

(ES. 8 b, 9 a-e, 10 a-d, 12 a, b, e)

ES.8 The student will investigate and understand geologic processes including plate tectonics. Key concepts include:

- ☐ b) processes (faulting, folding, volcanism, metamorphism, weathering, erosion, deposition, and sedimentation) and their resulting features;

ES.9 The student will investigate and understand how freshwater resources are influenced by geologic processes and the activities of humans. Key concepts include:

- ☐ a) processes of soil development;
- ☐ b) development of karst topography;
- ☐ c) identification of groundwater zones including water table, zone of saturation, and zone of aeration;
- ☐ d) identification of other sources of fresh water including rivers, springs, and aquifers with reference to the hydrologic cycle;
- ☐ e) dependence on freshwater resources and the effects of human usage on water quality;

ES.10 The student will investigate and understand that many aspects of the history and evolution of the Earth and life can be inferred by studying rocks and fossils. Key concepts include:

- ☐ a) traces or remains of ancient, often extinct, life are preserved by various means in many sedimentary rocks;
- ☐ b) superposition, cross-cutting relationships, index fossils, and radioactive decay are methods of dating bodies of rock;
- ☐ c) absolute and relative dating have different applications but can be used together to determine the age of rocks and structures;
- ☐ d) rocks and fossils from many different geologic periods and epochs are found in Virginia.

ES.12 The student will investigate and understand the origin and evolution of the atmosphere and the interrelationship of geologic processes, biologic processes, and human activities on its composition and dynamics. Key concepts include:

- ☐ a) scientific evidence for atmospheric changes over geologic time;
- ☐ b) current theories related to the effects of early life on the chemical makeup of the atmosphere;
- ☐ e) potential atmospheric compositional changes due to human, biologic, and geologic activity.

Essential Questions

You should be able to answer the following question with confidence about this topic.

- ☐ Scientific evidence from rocks and fossils provide understanding of the history and evolution of earth. How does scientific evidence from rocks and fossils provide understanding of the history and evolution of the earth?
- ☐ Geologic processes and biologic processes affect the origin and evolution of atmosphere. How is the earth's atmosphere affected by geologic and biologic processes?
- ☐ How can absolute dating techniques be used to place a numerical age on an event?
- ☐ Absolute and relative dating techniques can be used to determine the origin and geologic history of the earth. How can the geological principles, such as superposition and cross cutting relationships, be used to determine the relative age of rocks?
- ☐ Mountain building, mass extinction, evolution, and climate changes are all part of Earth's history. Can you explain how mountain building, mass extinction, evolution, and climate changes are part of Earth's history?

Part One: Fossil Formation and Types

A ***fossil*** is the remains, impressions, or other evidence of the former existence of life preserved in rock. Examples are shells, bones, petrified trees, impressions made by leaves, insects in amber, footprints, or even burrows made by worms. The evidence can be:

- ***mold*** – a cavity left by an organism where the ground hardened before the organism had decayed
- ***casts*** – where the cavity left by an organism has been filled, usually by minerals
- ***petrified remains*** – where there has been a molecule-for-molecule replacement of the original organism, turning it into a rock like object made of minerals
- ***Carbon film*** is the thin film of a carbon impression left by an object
- ***Original remains*** are when the actual remnants of an organism are discovered. This may be in the form of a bone or tooth or shell, in frozen remains (like a wooly mammoth) or an insect in ***amber***. In each case, actually portions of the organism are found.

- ***Trace fossils*** are not the actual organism but rather the evidence that an organism once existed. Examples of this would include tracks, nests, or tools (for early humans).

Nearly all fossils are found in sedimentary rock. Fossils are more likely to form if organisms have hard parts and if they are quickly buried. Sometimes, a fossil that lived in a wide geographic area, lived a short time and is easily recognizable is referred to as an ***index fossil***. These index fossils assist geologists in determining ages of other things found in that same layer of rock.

Key Vocabulary: amber, carbon film, cast, fossil, index fossil, mold, original remains, petrified remains, trace fossil

Part Two: Relative Dating

Relative dating (also called relative time or relative age) places events in a sequence without assigning any numerical ages. This does not give the time of the actual event, it just indicates the age in comparison with other events. Most geologic work is done using relative time. There are rules, laws and principles that are used to determine the relative age of rock layers. These layers in one location are compared to layers in another location and based on the ***correlation*** (how the layer sequence matches up), scientists can determine what happened geologically They are…

- ***Horizontality*** states that all rock layers are initially laid down horizontally. If one or more layers are not horizontal this indicates some sort of tectonic action such as ***uplifting***.
- ***Superposition*** states that in a sequence of undisturbed sedimentary rocks, the oldest rock will be at the bottom of the sequence and the youngest will be at the top.
- ***Cross-Cutting*** Relationships states that an igneous rock is younger than the rocks it has intruded (cut across). One of these cross-cutting relationships is an ***igneous intrusion*** where magma is squeezed into cracks (***faults***) in rock layers or in between layers. Also, the event that caused a fault is younger than any rocks the fault has cut across.
- ***Included Fragments*** states that pieces of one rock found in another rock must be older than the rock in which they are found.
- An ***unconformity*** is a place in the rock record where layers of rock are missing. Unconformities are gaps in geologic time.

A key component of understanding geologic history is the concept of ***uniformitarianism***. This means that geologic processes that are occurring today also occurred in the past. Because of that understanding, it allows scientists to make assumptions about how rock layers were formed.

Key Vocabulary: correlation, cross-cutting, fault, horizontality, igneous intrusion, included fragments, relative dating, superposition, unconformity, uplift

Part Three: Absolute Dating

Absolute dating (also called absolute time or absolute age) time places a numerical age on an event. This is difficult and expensive to obtain.

- ***Radioactive decay*** is used to determine the absolute age of rocks.
- ***Half-life*** is the time required for half a given sample of a radioactive isotope to decay. Two things are absolutely consistent about half-life…the amount of time for each half-life and the fact that 50% of the radioactive material will decay for each half-life…time and amount.
- The original radioactive material is referred to as the ***parent*** material and the resulting decay material is referred to as the ***daughter*** material.
- ***Carbon-14*** is a method of dating that is only used on objects that were once living. It has a half-life of 5730 years.
- ***U-238*** (uranium) is another radioactive element which is found in rocks that decays into Pb-206 (lead). It has a half-life of 4.5 billion years.

Key Vocabulary: absolute dating, carbon-14, daughter, half-life, parent, radioactive decay, U-238

Part Four: The Geologic Time Scale

The Geologic Timetable is a summary of the major events in Earth's history preserved in the rock record. There are 4 major divisions of time. The largest division of time is an ***eon***. Mostly, we deal with ***eras***, which are also very large divisions. Eras are major subdivisions based on differences in life forms. Eras are divided into smaller segments called ***periods*** based on types of life existing at the time and geologic events. Like eras, periods differ from one another in plant and animal life although less than between eras. Some of the periods are further divided into ***epochs***. These divisions are shorter and changes in life are not as large as between periods. The four major eras are:

- ***Precambrian*** (which can be divided into Archeozoic and Proterozoic eras): The Precambrian Era began 4.6 billion years ago, when life first appeared. Life-forms present were cyanobacteria, invertebrates – jellyfish, marine worms. The Precambrian Era was the longest era. It produced very few fossils. Bacteria formed O_2, Ozone (O_3) began to develop, and the atmosphere began to form.
- ***Paleozoic*****:** The Paleozoic Era (the age of marine invertebrates) is the second oldest era of our Earth's history. Paleozoic means "Ancient Life" and lasted 345 million years. This is the first era in which scientists have found numerous fossils. It began about 600 million years ago with the first trilobites, a small, shelled sea creature resembling a modern crab. The Paleozoic is called the "Age of Fish". The continents were all connected into one huge landmass called Pangaea during the early Paleozoic.
- ***Mesozoic***: Mesozoic means "Middle Life" and began about 225 million years ago and ended about 70 million years ago. This era is called the "Age of the Reptiles". The era started with the rise of the dinosaurs. The first birds were evolved during the Mesozoic. The end of the Mesozoic was marked by the extinction of the dinosaurs. There are numerous theories as to why the great dinosaurs became extinct. The leading theory is that an asteroid hit in an area called the Chicxulub Crater in Mexico. This would have caused tremendous climate change in a short amount of time which the dinosaurs were unable to adapt to, causing their extinction.
- ***Cenozoic***: The Cenozoic Era is also called the "Age of the Mammals". It began about 65 million years ago as the great lizards, the dinosaurs became extinct. This led to a rise in the mammal population.

We are currently living in the Cenozoic Era, the Quarternary Period and the Holocene Epoch.
Key Vocabulary: Cenozoic, eon, epoch, era, Mesozoic, Paleozoic, period, Precambrian

Part Five: Origin of Earth's Atmosphere

The early atmosphere contained little oxygen and more carbon dioxide than the modern atmosphere. Early life such as ***cyanobacteria*** (blue-green algae) consumed carbon dioxide and generated oxygen by a process called ***photosynthesis***. It was only after early photosynthetic life generated oxygen that animal life became possible. Part of the oxygen created combined to form ***ozone*** which protects us from harmful ultraviolet rays from the sun.
Key Vocabulary: cyanobacteria, ozone, photosynthesis

Sample SOL Questions

1. Volcanic ash has occasionally formed molds of animals. This occurs when the ash covers the animal and —

F replaces the animal's soft tissues
G enters the animal's body cavity
H hardens before the animal decays
J mineralizes the animal's bones

2. In which type of rock are fossils *most* likely to be found?

F igneous intrusive **G** igneous extrusive **H** sedimentary **J** metamorphic

3. Rock layers tell a story about their past. What is the basic assumption that is made when reading this story?

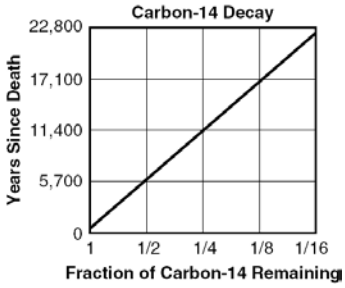
F The composition of the Earth's atmosphere has been constant.
G The Earth's crust cooled and then remelted before rock layers began to form.
H The processes in the rock cycle were the same in the past as they are today.
J Chemical reactions in the past were slower than they are today.

4. Which of these is the *best* indication of the relative age of a rock layer?

A The thickness of the layer
B The chemical makeup of the layer
C The position of the layer compared to other layers
D The distance the layer extends over the Earth

5. According to the graph on the right, a piece of timber containing one-eighth of the amount of carbon-14 that is found in a living tree died about how many years ago?

A 5,700 years
B 11,400 years
C 17,100 years
D 22,800 years



6. Of the following, the largest division on the geologic time scale is —

A a year **B** an epoch **C** an era **D** a period

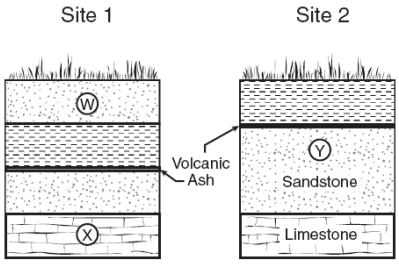
7. Which vertebrate did *not* live during the time of the dinosaurs (the Mesozoic Era)?

A  **B**  **C**  **D** 

8. Not all fossils have been preserved inside soil or rock. Explorers in Siberia have discovered the bodies of ancient mammoths so well-preserved that the flesh could be eaten. What do you think preserved the mammoths in such a perfect state?

A Water **B** Ice **C** Leaf mold **D** Carbon dioxide

9. These geologic cross sections show the location of three fossilized species (W, X, and Y) found in rock layers at two nearby sites. Species X is probably the oldest species because it is found —



F below species W **H** above the ash layer
G in the lowest layer **J** in sandstone

10. What is the best evidence that many different geologic periods are represented in Virginia?

A The length of its rivers **C** The presence of fossils of different ages
B The location of the Piedmont **D** The amount of chemical weathering

11. The table on the right shows the area and average depth of the Pacific and Atlantic Oceans. Approximately how many times greater is the volume of water in the Pacific Ocean than in the Atlantic Ocean?

Ocean Dimensions		
Ocean	Area (million sq km)	Average Depth (km)
Pacific	165	4.3
Atlantic	82	3.9

F 2 times **H** 2,000 times
G 20 times **J** 2,000,000 times

12. Which of the following is *not* a fossil fuel?

A Coal **B** Wood **C** Petroleum **D** Natural gas

13. Jellyfish have rarely been fossilized because they —

A contain no carbon compounds **C** are generally found in oceans
B are very rare animals **D** have soft bodies

14. The canyon shown in the picture was most likely formed by —

F a volcano **G** high winds **H** earthquakes **J** running water

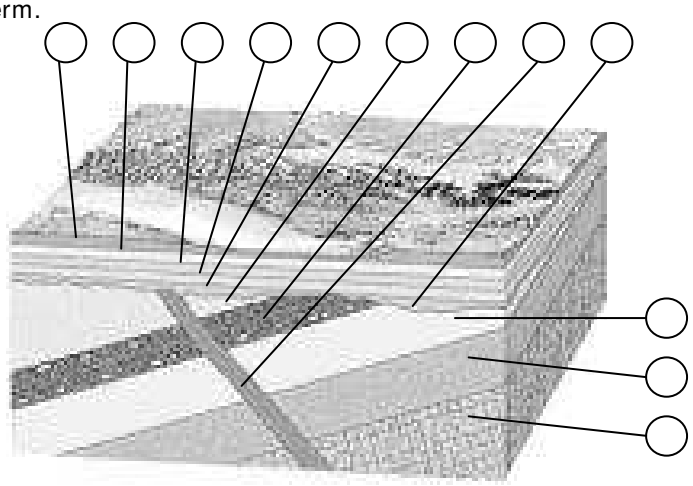
15. Which of the following may preserve ancient remains of plants and animals?

A Granitic intrusion **C** Foliated schist
B Volcanic ash **D** Folded gneiss

Application

One the following pages, you will find diagrams to label, information to be completed or questions to be answered. Please complete the pages accurately and study the information contained there.

Principles, Rules & Laws of Relative Dating: Number the events (1 – 12) beginning with the oldest, ending with the youngest. Additionally, define the terms below AND indicate the event numbers that are associated with that term. Numbers may be used with more than one term.



cross-cutting relationship – _____

fault – _____

horizontality – _____

igneous intrusion – _____

included fragments – _____

superposition – _____

unconformity – _____

uplift – _____

What is an index fossil and why is it important?

Fossil Types: List the fossil types and define each.

_____ – _____

_____ – _____

_____ – _____

_____ – _____

_____ – _____

_____ – _____

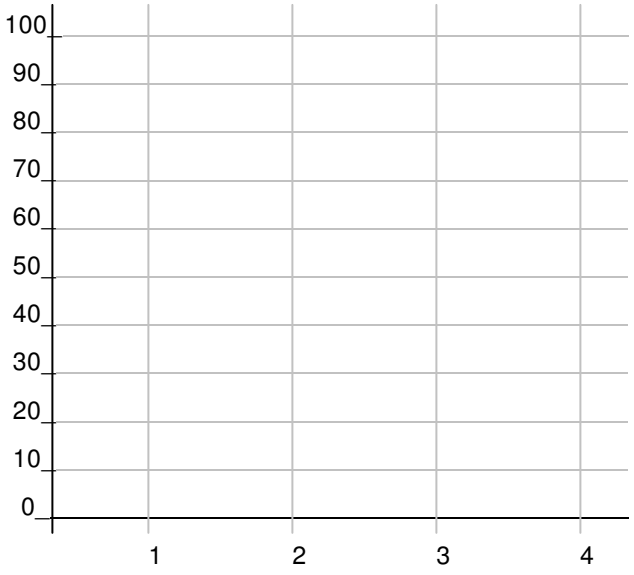
Conditions Necessary to Form Fossils: List the 3 conditions necessary to form fossils. For the rock type that fossils are usually found it, explain why other types are not possible.

1. _____

2. _____

3. _____

Absolute Dating: Define the terms on the right. Then use the graph on the left to demonstrate how absolute dating by the use of radioactive materials works. For each half life, place a point on the graph. Above that point put the percentage of daughter material and below the point, put the percentage of parent material, demonstrating the relationship between the two amounts.



absolute dating – _____

carbon-14 – _____

daughter material – _____

half life – _____

parent material – _____

radioactive decay – _____

Geologic Time: There are 4 major geologic divisions of time. Put them in order of largest to smallest.

1._____ 2._____ 3._____ 4._____

In each of the 4 boxes below, indicate the major era represented by the picture. Additionally, describe the era and give its approximate dates. Finally, indicate the reason that era came to an end.

Era: _____

Dates: _____

Description of Era: _____

_____

_____

Reason it came to an end: _____

_____

Era: _____

Dates: _____

Description of Era: _____

_____

_____

Reason it came to an end: _____

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Era: _____

Dates: _____

Description of Era: _____

_____

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Reason it came to an end: _____

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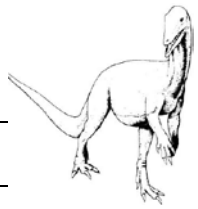


Era: _____

Dates: _____

Description of Era: _____

_____

_____

Reason it came to an end: _____

_____

Virginia Geology / Chesapeake Bay

(ES. 8 a; E.S. 7 c-e, 9 f, 11a-c)

ES.8 The student will investigate and understand geologic processes including plate tectonics. Key concepts include:

- ☐ a) how geologic processes are evidenced in the physiographic provinces of Virginia including the Coastal Plain, Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau;

ES.7 The student will investigate and understand the differences between renewable and nonrenewable resources. Key concepts include:

- ☐ c) resources found in Virginia;
- ☐ d) making informed judgments related to resource use and its effects on Earth systems;
- ☐ e) environmental costs and benefits.

ES.9 The student will investigate and understand how freshwater resources are influenced by geologic processes and the activities of humans. Key concepts include:

- ☐ f) identification of the major watershed systems in Virginia including the Chesapeake Bay and its tributaries.

ES.11 The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include:

- ☐ a) physical and chemical changes (tides, waves, currents, sea level and ice cap variations, upwelling, and salinity concentrations);
- ☐ b) importance of environmental and geologic implications;
- ☐ c) systems interactions (density differences, energy transfer, weather, and climate);

Essential Questions

You should be able to answer the following question with confidence about this topic.

- ☐ Virginia is divided into five physiographic provinces based on rock type and topography. How do Virginia's five provinces reflect its geologic history?
- ☐ Water in the Chesapeake Bay comes from a variety of sources and is impacted by human and natural activities. How are the resources and productivity of the Chesapeake Bay impacted by human and natural activities and the source from which the water comes?
- ☐ Resources in the Chesapeake Bay are impacted by the water quality of the bay, including nutrient levels and the abundance of submerged aquatic vegetation. In what ways are Chesapeake Bay resources impacted by the water quality?

Part One: Characteristics of Virginia's 5 Physiographic Provinces

Virginia crosses 5 of the 24 geologic provinces of the United States. They are…

The ***Coastal Plain*** region…

- contains the youngest sedimentary rocks in Virginia and has a terraced landscape
- has sediments that usually consist of sand, gravel, shells and clay
- consists of a great variety of fossil beds which contain fossilized shells, bones and teeth.
- A part of the Eastern Shore of the Coastal Plain, known as the Barrier Islands, exhibits growth and destruction phases due to changing sea levels during the past Ice Ages.
- A large meteor impact influenced much of the shape of the Chesapeake Bay.
- Most of the sediments in this area came from the Appalachian Mountains. This means that the Coastal Plain is the youngest of the Virginia provinces.
- Important ***mineral*** resources found in the Coastal Plain include deposits of titanium bearing minerals.
- ***Oil*** and ***Natural Gas*** can also be found offshore.

The ***Piedmont*** region…

- consists of low rolling hills and shallow valleys
- Dominant rocks found in this province are igneous and metamorphic (slates, marbles, granite and quartzite).
- Much deformation (such as folding, faulting and fracturing) has occurred to the rocks in this area.
- There are many unmetamorphosed (no heat and pressure applied) sandstone and shale found in basins that are around 205-245 mya.
- Many preserved fossils – including dinosaur tracks – were found here.
- Important minerals are ***gold*** and ***pyrite***.
- some coal beds and ***methane*** are also found here.

The ***Blue Ridge*** region…

- is a mountain chain that ranges from 2 miles wide at the Potomac River to 50 miles wide at the VA-NC border.
- These mountains are very rugged and covered with weathered igneous and metamorphic rock.
- Three major rivers breach these mountains: The James River, The Potomac River and The Roanoke River.
- Precambrian aged metamorphosed rock as well as ancient lava flows make up these mountains.
- The weathered rocks of this area supply the sediment to the provinces towards the coast.
- ***Copper, iron, tin*** and ***turquoise*** are mined from the Blue Ridge.

Valley and Ridge region…

- contains sedimentary rocks that date back 550 mya.
- Rocks include ***limestone***, sandstone, and shale. Most of the caves of Virginia formed from the limestone deposits in this province.
- Extreme faulting and folding with very old rock terrains can be found here.
- Mineral resources include ***lime, lead,*** tin and iron.
- Oil***,*** gas and ***coal*** are also found here.

The ***Appalachian Plateau*** region…

- contains deep narrow valleys and steep, rugged mountain sides
- contains sandstone and shale as old as 320 mya.
- ***Coal beds*** can be found throughout. The coal is what makes this area economically important. There are some small oil fields.

Key Vocabulary: Appalachian Plateau, Blue Ridge, Coastal Plain, coal, copper, gold, iron, lead, lime, limestone, methane, mineral, natural gas, oil, Piedmont, pyrite, tin, turquoise, Valley and Ridge

Part Two: The Chesapeake Bay

An ***estuary***…

- is a semi-enclosed body of water that has a free connection with the sea
- has more food for organisms, but the organisms usually have to deal with large temperature and salinity changes, high silt content and pollution. Many marine organisms are filter feeders so silt can be a major problem. Many of these filter feeders are important as food to humans.

A ***watershed*** is the ***drainage area*** for a bay or river. The six states that make up the watershed of the Chesapeake Bay are: Virginia, Maryland, West Virginia, Delaware, New York, and Pennsylvania. All of Virginia's water ends up in one of 3 major watersheds…the Chesapeake Bay, the North Carolina Sounds or the Gulf of Mexico.

Some Bay facts…

- The ***Chesapeake Bay*** is the largest estuary in the United States.
- There are 5 major rivers that flow into the bay. From South to North, they are The ***James***, ***York***, ***Rappahannock***, ***Potomac***, and the ***Susquehanna*** Rivers.
- The Susquehanna River provides about 50% of the fresh water coming into the Bay.
- The river empties an average of 19 million gallons of water per minute.
- The Bay area is home to over 15,000,000 people!
- About 50,000 commercial vessels enter the Bay each year. All these people and activities put a strain on the Bay ecology.

The Bay is home to over 3600 species of living organisms and has 5 basic communities.

- ***Marsh*** dwellers are located in and around marshes. They include small fish, birds, and marsh grasses.
- Submerged Aquatic Vegetation ***(SAV)*** Communities are important for many reasons. They include ducks, crabs, and eelgrass.
- The ***Plankton*** Community includes the drifters of the Bay as well as phytoplankton, bacteria, and zooplankton.
- The ***Benthic*** Community refers to the organisms that live at the bottom of the Bay. Benthic organisms include oysters, clams, barnacles, and mud crabs.
- The ***Nekton*** Community refers to the swimmers of the Bay. Nekton Communities are croaker, spot, and menhaden.

Bay Pollution: There are two types of pollution that affect the Chesapeake Bay…

- ***point source pollution*** – when you can identify the exact location of the origin of the pollution (a wastewater treatment plant, an industry, an oil spill, etc.)
- ***non-point source pollution*** – when the origin of the pollution is from a large area or region (farm land, urban areas, etc.) This is the most common type in Virginia. Example: Farmers and homeowners fertilize

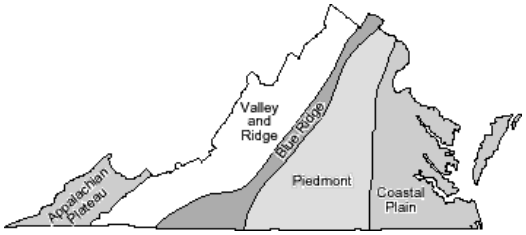
their farms or lawns. That fertilizer ends up in the rivers and eventually into the Bay. In the rivers and the Bay, the fertilizer causes major algae blooms. These algae blooms block out the sunlight. The plants on the bottom cannot receive sunlight and die off. Their decomposition removes oxygen from the Bay and ends up killing off marine life that depends on the plants for food and/or habitat.

Key Vocabulary: benthic, Chesapeake Bay, drainage area, estuary, James, marsh, nekton, non-point source, plankton, point source, Potomac, Rappahannock, SAV, Susquehanna, watershed, York

Sample SOL Questions

1. In which province would clay, sand, and gravel deposits be found?

A Appalachian Plateau
B Valley and Ridge
C Blue Ridge
D Coastal Plain



2. Many quarries in Virginia produce crushed stone. What industry uses the most crushed stone?

A Plastics **B** Construction **C** Electronics **D** Steel

3. Which recent geologic processes commonly occur in the Coastal Plain region of Virginia?

A Crustal uplift and rock deformation
B Rifting and intrusion
C Erosion and deposition
D Subduction and metamorphism

4. The folding and faulting found in the rocks of the Blue Ridge Mountains of Virginia were created by —

A collisions of continental plates
B wave action of prehistoric ocean
C the Coriolis effect
D heating and cooling of the prehistoric atmosphere

5. Which natural resource found in Virginia is a common source of energy?

F Bauxite **G** Limestone **H** Coal **J** Zinc

6. Which of the following minerals found in the northern Piedmont province is known as "fool's gold"?

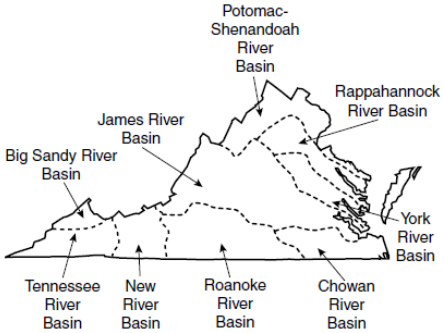
A Pyrite **B** Hematite **C** Galena **D** Limonite

7. The presence of many metamorphic rocks in Virginia is an indication that the area has been subjected to —

A intense heat and pressure
B limited volcanic activity
C deep ocean venting
D massive solar bombardment

8. According to the above map, the largest river basin in Virginia is drained by the —

F Potomac-Shenandoah Rivers
G York River
H James River
J Roanoke River

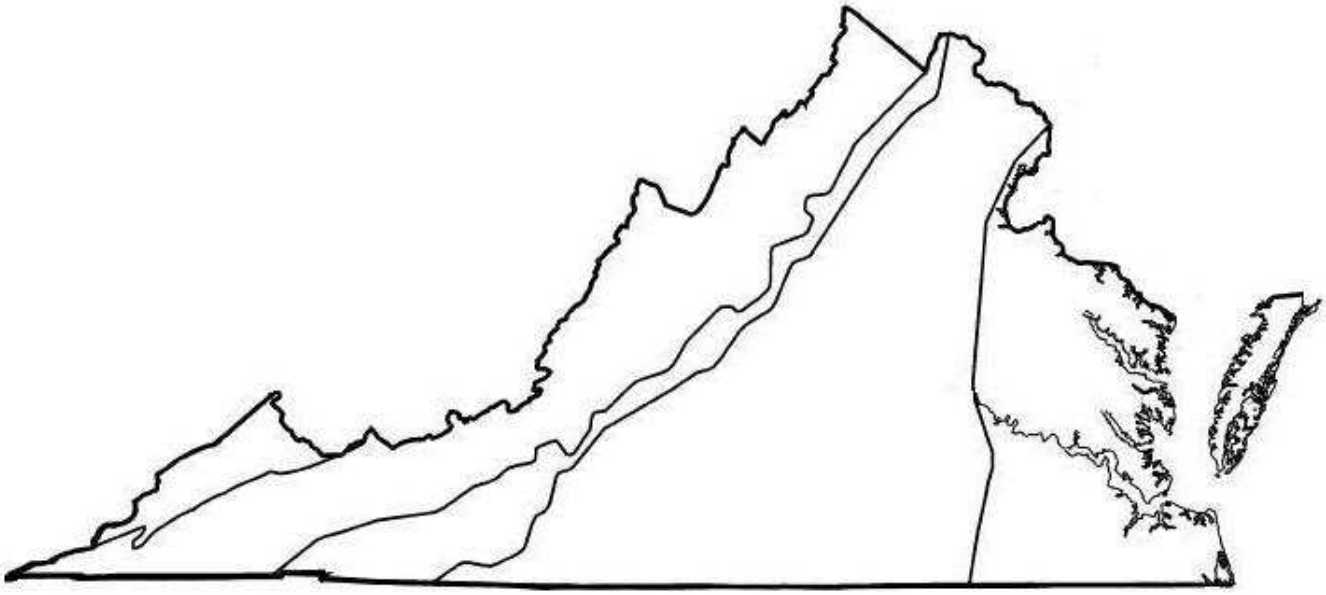


There have been no specific questions about the Chesapeake Bay as yet.

Application

One the following pages, you will find diagrams to label, information to be completed or questions to be answered. Please complete the pages accurately and study the information contained there.

Virginia Geology: Label each of Virginia's 5 physiographic provinces. Then complete the table below the map. If it would help, color each province shown on the map a different color. Then, color each province's information from your completed table with the color that matches the map color.



Prov.	Rock Found	Topography	Fossils	Resources	Key Facts

States in the Chesapeake Bay Watershed: _____

_____

Virginia Waters' Watersheds: _____

_____

5 Main Tributaries of the Bay (locate them on the map): _____

_____

Estuary (definition)**:** _____

_____

Watershed (definition)**:** _____

_____

Bay Communities:

1. SAV - _____

_____

2. Marsh Dwellers - _____

_____

3. Nekton: _____

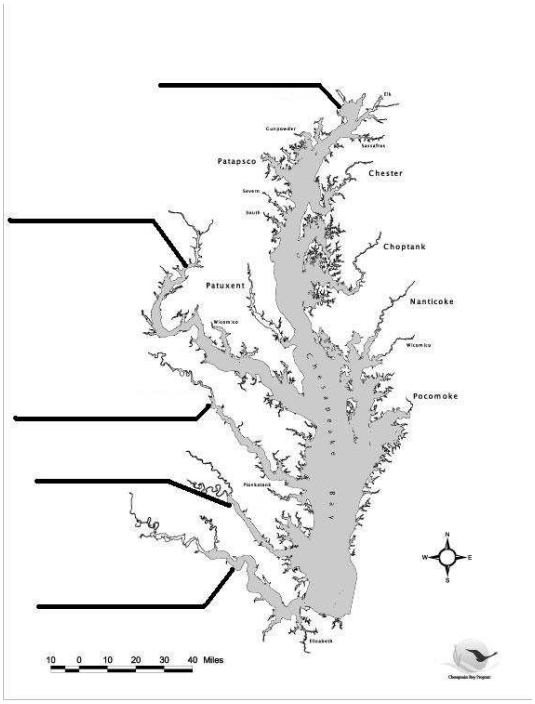
_____

4. Plankton - _____

_____

5. Benthos - _____

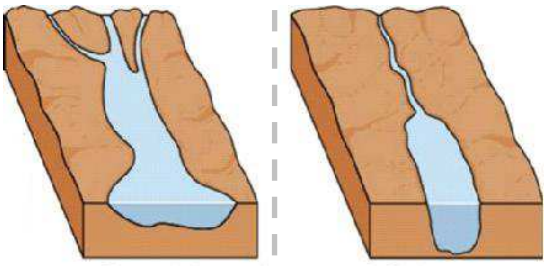
_____



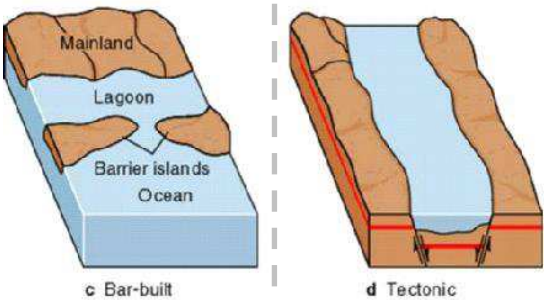
Point Source Pollution - _____

Non-point Source Pollution - _____

Estuaries: Describe each estuary shown below. Indicate the one that is the same type as the Chesapeake Bay.



a Drowned river mouth **b** Fjord



c Bar-built **d** Tectonic

Oceanography

(ES. 2a, 4b, 7 d, e, 8 c, 11a- e, 13 d)

ES.2 The student will demonstrate scientific reasoning and logic by:
- ☐ a) analyzing how science explains and predicts the interactions and dynamics of complex Earth systems;

ES.4 The student will investigate and understand the characteristics of the Earth and the solar system. Key concepts include:
- ☐ b) sun-Earth-moon relationships (seasons, tides, and eclipses);

ES.7 The student will investigate and understand the differences between renewable and nonrenewable resources. Key concepts include:
- ☐ d) making informed judgments related to resource use and its effects on Earth systems;
- ☐ e) environmental costs and benefits.

ES.8 The student will investigate and understand geologic processes including plate tectonics. Key concepts include:
- ☐ c) tectonic processes (subduction, rifting and sea floor spreading, and continental collision).

ES.11 The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include:
- ☐ a) physical and chemical changes (tides, waves, currents, sea level and ice cap variations, upwelling, and salinity concentrations);
- ☐ b) importance of environmental and geologic implications;
- ☐ c) systems interactions (density differences, energy transfer, weather, and climate);
- ☐ d) features of the sea floor (continental margins, trenches, mid-ocean ridges, and abyssal plains) reflect tectonic processes;
- ☐ e) economic and public policy issues concerning the oceans and the coastal zone including the Chesapeake Bay.

ES.13 The student will investigate and understand that energy transfer between the sun, Earth, and the Earth's atmosphere drives weather and climate on Earth. Key concepts include:
- ☐ d) weather phenomena and the factors that affect climate including radiation and convection.

Essential Questions

You should be able to answer the following question with confidence about this topic.
- ☐ Earth's surface changes constantly. How does the earth's surface change?
- ☐ Sea floor features can be created and destroyed by geologic processes. How are sea floor features created and destroyed?
- ☐ Ocean resources are limited and their use impacts the environment and economy. What impact does the use of ocean resources have on the environment and economy?
- ☐ Human activities impact ocean resources. How can human activities impact ocean resources?
- ☐ Scientists use maps, globes, models, charts and imagery to interpret and measure Earth's surfaces. How do scientists use maps, globes, models, charts and imagery to interpret and measure the sea floor?
- ☐ How can technology be used to make and interpret maps, models and images of the sea floor?

Part One: Interacting Processes and Systems

The ocean covers 70 % of the Earth. It contains dissolved salts with ions such as chloride, sodium, magnesium, and potassium. ***Salinity*** is a measure if the amount of salts dissolved in seawater. Almost all of the energy that heats up the oceans comes from the sun, but light and heat do not penetrate very deeply into the ocean. Oceanographers divide the ocean into three temperature layers.

- The ***surface zone*** is warm with sunlight. The surface zone is also called the mixed layer because wind and waves mix heat evenly through this zone.
- The layer of ocean directly beneath the mixed layer, in which the temperature changes rapidly, is called the ***thermocline***. This middle zone is penetrated by little light. The middle zone has a cold temperature.
- The ***deep zone*** is very cold and has no sunlight.

Ocean water moves by currents and waves.

- ***Currents*** are mass movements or flows of ocean water.
- Most waves on the ocean surface are generated by ***wind***. The top of a wave is the ***crest***; the bottom is the ***trough***. The distance between two crests or troughs is the ***wavelength***. The distance between the crest and the trough is the ***wave height***.

- A *tsunami* is a very large wave produced by seismic activity on the ocean floor.
- The *tides* are the daily periodic rise and fall of water level caused by the gravitational pull of the sun and moon. *Spring tides* occur when the Sun, Earth and Moon are in a straight line making high tides higher and low tides lower. *Neap tides* occur when the Sun and the Moon are at right angles to the Earth making high tides lower and low tides higher.
- There are large current systems called *gyres* in the oceans that carry warm water towards the poles and cold water towards the equator. They move by *convection* and by *density*.
- Estuaries, like the Chesapeake Bay, are areas where fresh and salt water mix, producing variations in salinity and high biological activity.
- *Upwelling* brings cold, nutrient-rich water from the deep ocean to the surface and are areas of rich biological activity.
- Sea level falls when glacial ice caps grow and rises when ice caps melt.
- The stored heat in the ocean drives much of the Earth's weather. The stored heat in the ocean causes climate near the ocean to be milder than the climate in the interior of continents.

Key Vocabulary: convection, crest, current, deep zone, density, gyre, mixed layer, neap tide, salinity, spring tide, surface zone, thermocline, tide, trough, tsunami, upwelling, wave height, wavelength, wind

Part Two: Ocean Topography

There are 8 basic features of the ocean floor.

- The *continental shelf* is really a gently sloping part of the continent that is under shallow water.
- The *continental slope* is the zone of steeply sloped sea floor leading from the continental shelf toward the ocean bottom.
- Separating the continental slope from the ocean bottom is the *continental rise* and is made up of sediments, or small bits of rock and plant and animal remains.
- The *abyssal plain* is a flat stretch of the deep ocean around the margins of the continents.
- In the abyssal plain you may find *seamounts* which are underwater volcanoes at current or former location of hot spots.
- In the abyssal plain you may also find *guyots* which are seamounts that are no longer active and have flat tops due to erosion by water movement.
- *Mid-ocean ridges* are chains of underwater mountains that run throughout the ocean basins and are a result of plate tectonic movement at a divergent boundary. This is where magma is squeezing through the crack in the plates and is building up into ridges.
- In the middle of the mid-ocean ridge is the *rift valley*. This is the location of the 'crack' in the plates. Expect to find volcanic activity.
- The deepest places in the ocean are called *trenches*. Trenches are narrow channels more than 6km deep. They are caused by converging tectonic plates at a subduction zone. Expect to find volcanoes.

Key Vocabulary: abyssal plain, continental rise, continental shelf, continental slope, guyot, mid-ocean ridge, rift valley, seamount, trench

Part Three: Ocean Resources and Human Activity

Algae in the oceans are an important source of atmospheric oxygen. The oceans are an important source of food and *mineral* resources as well as a venue for recreation and transportation.
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.
Key Vocabulary: over-fishing, pollution, resources

Sample SOL Questions

1. Seawater is typically denser than freshwater due to seawater's —

A higher salinity **B** lower freezing point **C** smaller mass **D** greater depth

2. When the sea floor spreads apart, volcanoes and ridges are formed because —

A sediments are deposited where the floor spreads, building ridges
B as the plates pull apart, magma moves to the surface, building ridges
C ocean water pushes down on the surrounding sea floor, pushing up ridges
D underwater earthquakes lift the sea floor into long ridges

3. All of the following features of the ocean indicate tectonic activity *except* —

A abyssal plains **B** mid-ocean ridges **C** seamounts **D** trenches

4. Why is the surface temperature of the oceans more variable than the water near the ocean floor?

A Most energy is exchanged at the surface.
B Most animals live near the surface.
C The water is less dense at the surface.
D The salt concentration is more variable at the surface.

5. Many species of the order Cetacea (whales, dolphins, and porpoises) have become so scarce that they are now protected by international law. Which of the following probably did NOT contribute to the decline in these populations?

A the whaling industry **B** fishing nets **C** ocean pollution **D** increased carbon dioxide in the air

6. The two *most* common ions found in ocean water are —

F chloride & sodium **G** potassium & calcium **H** phosphate & nitrate **J** magnesium & sodium

7. Which of these describes the most common way that material is added to a continental shelf?

A Evaporation from continental watersheds
B Deposition of continental sediments
C Eruption of continental volcanoes
D Subduction of continental plates

8. Most water leaves the ocean through evaporation and returns to the ocean through —

A surface runoff **B** ground water **C** transpiration **D** precipitation

9. The Marianas Trench in the Pacific Ocean is 36,160 feet below sea level. This deep oceanic trench is caused by —

A swift ocean currents eroding away the ocean floor
B the collapse of an empty magma chamber in a large volcano
C excessive boat traffic disrupting the normal sedimentation process
D two tectonic plates colliding and one plunging below the other

10. Why is the surface temperature of the oceans more variable than the water near the ocean floor?

A Most energy is exchanged at the surface.
B Most animals live near the surface.
C The water is less dense at the surface.
D The salt concentration is more variable at the surface.

11. All of the following are sources of energy derived from the ocean *except* —

F coal **G** thermal **H** tides **J** waves

12. Fish are abundant in areas where the ocean is upwelling because it —

A causes currents that carry fish into the area
B brings nutrients to the surface
C causes surface turbulence that attracts fish
D changes tidal flow in that area

13. The surface of the sea is not level due to all of the following *except* —

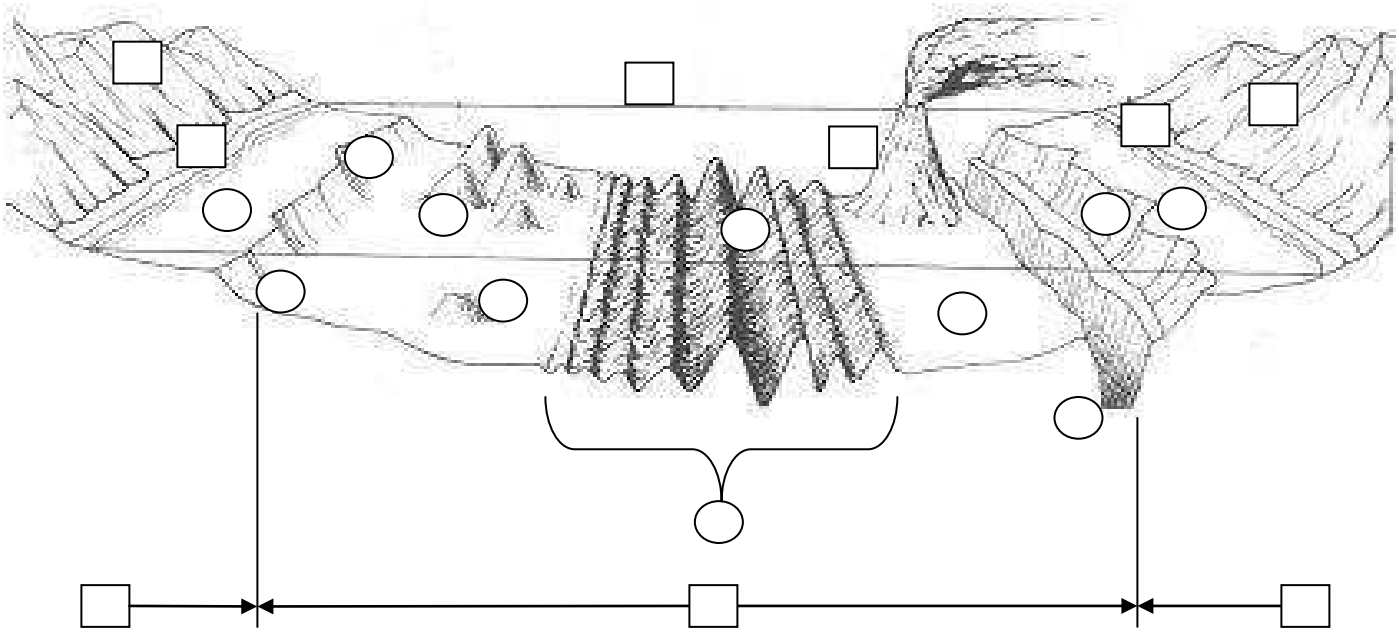
F currents **G** tides **H** salinity **J** winds

Application

One the following pages, you will find diagrams to label, information to be completed or questions to be answered. Please complete the pages accurately and study the information contained there.

Written and assembled by D. L. Edwards with input from other valued teachers throughout Virginia. Strasburg High School, Strasburg, VA, May/June, 2008; Revised May 2010

The Ocean Floor: Label the items below. The boxes are for things that need no definition. The circles are for things that should be defined below. Write the number in the boxes or circles that matches the terms below. Color parts of the diagram as needed.



Terms for boxed items: The number in parentheses indicates how many times it appears in the picture.

A. Beach (2)
B. Continents(2)
C. Island (1)
D. Oceanic Crust (1)
E. Water Line/Sea Level (1)
F. Continental Margin made up of continental crust (2)

Terms for circled items: The number in parentheses indicates how many times it appears in the picture. DEFINE!

1. abyssal plain (1) – _____

_____

2. continental rise (1) – _____

_____

3. continental shelf (2) – _____

_____

4. continental slope (2) – _____

_____

5. guyot (1) – _____

_____

6. mid-ocean ridge (1) – _____

_____

7. rift valley (1) – _____

_____

8. seamount (1) – _____

_____

9. trench (1) – _____

_____

The 3 main oceans are: _____, _____, and _____

What is SONAR? _____

Current – _____

_____

_____

_____

Surface Current – _____

_____

upwelling - _____

_____

_____

gyre – _____

_____

Coriolis Effect – _____

_____

_____

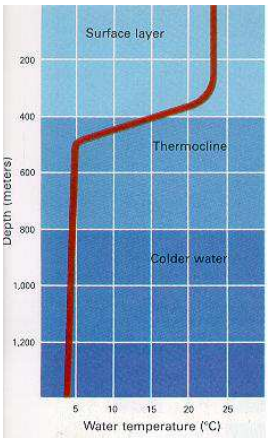
Deep Current – _____

_____

_____

The two main currents that affect the United States are the _____ on the east coast and the _____ on the west.

Ocean Zones: **Salinity:** _____



Define the zones found in the ocean.

Surface Layer – _____

_____

_____

Thermocline – _____

_____

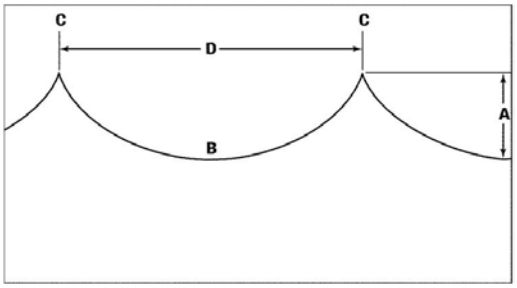
_____

Deep Water Zone – _____

_____

_____

Waves: Put the letter from the diagram with the term below. Also, define the terms shown below.



___Crest – _____

_____

___Trough – _____

_____

___Wavelength – _____

_____

___Wave height – _____

_____

Things that determine wave sizes: Define the terms below that relate to wave sizes.

Wind speed – _____

_____

Fetch – _____

_____

Duration – _____

_____

Special Waves or terms: Define the terms.

Breaker – _____

_____

_____

Tsunami – _____

_____

_____

Human impacts on oceans – _____

_____

Meteorology

(ES. 12 a-e, 13a-d)

ES.12 The student will investigate and understand the origin and evolution of the atmosphere and the interrelationship of geologic processes, biologic processes, and human activities on its composition and dynamics. Key concepts include:

- ☐ a) scientific evidence for atmospheric changes over geologic time;
- ☐ b) current theories related to the effects of early life on the chemical makeup of the atmosphere;
- ☐ c) comparison of the Earth's atmosphere to that of other planets;
- ☐ d) atmospheric regulation mechanisms including the effects of density differences and energy transfer;
- ☐ e) potential atmospheric compositional changes due to human, biologic, and geologic activity.

ES.13 The student will investigate and understand that energy transfer between the sun, Earth, and the Earth's atmosphere drives weather and climate on Earth. Key concepts include:

- ☐ a) observation and collection of weather data;
- ☐ b) prediction of weather patterns;
- ☐ c) severe weather occurrences such as tornadoes, hurricanes, and major storms;
- ☐ d) weather phenomena and the factors that affect climate including radiation and convection.

Essential Questions

You should be able to answer the following question with confidence about this topic.

- ☐ Geological and biological processes affect the origin and evolution of the atmosphere. Describe how geological and biological processes affect the origin and evolution of the atmosphere.
- ☐ Human activities change the atmosphere and climate. How can humans and geological processes change the atmosphere and affect climate?
- ☐ Weather patterns are created by the transfer of energy between the hydrosphere, atmosphere, and lithosphere. Summarize some processes that would explain how these things interact to create weather patterns.
- ☐ Scientists use maps, instruments, models, charts and imagery to forecast the weather. How can technology, meteorological instruments, maps and models be used to forecast the weather?
- ☐ How did early life affect the chemical make-up of the atmosphere?
- ☐ How does scientific evidence support the theory that the atmosphere changes over time?

Part One: Composition/ Structure of Earth's Atmosphere

Earth's atmosphere creates a unique balance between the energy received and lost from the sun. Compare Earth's atmosphere to that of other inner planets.

- Because of this and the fact that water exists in all 3 states, ***Earth*** has life. The earth's atmosphere is composed of: 78 % ***nitrogen***, 21 % ***oxygen***, between 0% and 3% ***water vapor***. Other gases make up 1% of the atmosphere.
- The atmosphere of ***Mars*** is mostly CO_2 and very thin. Mars does not have life but it has water but only in a frozen state…and that is probably below the surface. There is no evidence of existing surface water.
- There is no evidence of life on ***Venus***. The atmosphere of Venus is 95% CO_2 and is very dense. There is evidence that Venus may have had surface water at one time but it is too hot for it to have surface water now. There is water vapor in its atmosphere.
- There is no life on the ***moon***. The moon has no atmosphere. There is no evidence that the Moon ever had water.
- ***Mercury*** has no atmosphere. There is no life on Mercury. There is no evidence that Mercury ever had water.

The Earth's atmosphere can be separated into layers based on temperature.

- The ***troposphere*** is the layer of the atmosphere that is closest to the ground. It is heated by the earth's surface. Temperatures decrease as altitude increases. All weather occurs in the troposphere. The upper limit of the troposphere is the ***tropopause***.
- The ***stratosphere*** lies above the troposphere. It contains the ozone layer, the temperatures increase as altitude increases. This is the layer where ***jets*** fly and it is also the location of the ***ozone*** layer. The upper limit of the stratosphere is the ***stratopause***.

- The ***mesosphere*** lies above the stratosphere. Temperature decreases as altitude increases. This is the coldest layer. The upper limit of the mesosphere is the ***mesopause***.
- The ***thermosphere*** lies above the mesosphere. Temperatures increase as altitude increases. It can be subdivided into two parts. The lower thermosphere is called the ***ionosphere*** (area of electrically charged particles). Radio waves bounce off the ionosphere back to the earth. The ***exosphere*** is the upper part of the thermosphere. It is the outermost layer, and has no definite end. ***Satellites*** and space shuttles orbit earth in the exosphere. This is the warmest layer.

Key Vocabulary: Earth, exosphere, ionosphere, jet, Mars, Mercury, mesopause, mesosphere, moon, nitrogen, oxygen, ozone, satellite, stratopause, stratosphere, thermosphere, tropopause, troposphere, Venus, water vapor

Part Two: Atmospheric Mechanisms

Atmospheric regulation mechanisms including the effects of density differences and energy transfer. Three things can happen when Earth receives energy from the sun:

- ***reflection*** – Reflection occurs when energy is reflected back into space.
- atmospheric ***absorption*** – Atmospheric absorption occurs when energy is absorbed by the atmosphere.
- land/water absorption – Land/water absorption occurs when energy is absorbed by the surface. The land heats and cools more rapidly than the ocean. The oceans store heat.

Energy is transferred by radiation, conduction, and convection.

- ***Radiation*** is the transfer of energy by electromagnetic waves. We experience this as heat and light on Earth. The Ozone layer absorbs UV radiation. Smog and pollution keep some energy from being reflected, making areas hotter.
- ***Conduction*** is the transfer of heat thru direct contact (molecules bumping into one another) You have seen examples of conduction in your everyday life such as when feet get hot on hot asphalt or when pan gets hot on a hot burner.
- ***Convection*** is the transfer of heat by the flow of a heated material (either gas or liquid). Heat rises, cold falls creating convection currents. Deep water currents, plate tectonics, and air masses work this way.

Key Vocabulary: absorption, conduction, convection, radiation, reflection

Part Three: Air Masses and Fronts

Air that stays in one area for a long time takes on the weather of that area. Air masses are large bodies of air that have the same characteristics as the surface over which it developed. For example: If air stays in the Artic, it becomes cold. If air stays over the ocean, it becomes moist. It is important to understand the types, sources and paths of, and weather associated with air masses. There are 5 basic types of air masses.

- Continental Artic (***cA***) air masses come from very high latitudes and are extremely cold and dry.
- Continental Polar (***cP***) air mass comes from land areas that are at high latitudes and are cold and dry.
- Maritime Polar (***mP***) comes from cold oceans and are cold and humid.
- Continental Tropical (***cT***) comes from warm land areas and are hot and dry.
- Maritime Tropical (***mT***) comes from warm seas/oceans and are warm and humid.

A Front is the boundary between two air masses. There are 4 types of fronts. On a weather map, the symbols for the front are pointed in the direction the air mass is moving.

- A ***cold front*** occurs when cold air mass pushes under warm air mass. Narrow bands of storms are produced.
- A ***warm front*** occurs when warm air mass goes over a cold air mass. Wide bands of precipitation is produced.
- An ***occluded front*** occurs when two cold air masses merge, forcing warm air up. Strong winds and heavy precipitation are produced.
- A ***stationary front*** occurs when warm and cold air masses meet and stop. Light wind and precipitation are produced.

Key Vocabulary: cA, cold front, cP, cT, mP, mT, occluded front, stationary front, warm front

Part Four: Weather Patterns

Information regarding things that affect weather/climate...

- ***Weather*** is the present state of the atmosphere. Factors affecting weather include: air pressure, wind, and temperature.
- ***Climate*** is an average of the weather over a long period of time in a certain area.

- Latitude, large bodies of ***water***, ***mountains*** (elevation), and ***seasons*** affect climate. Latitude affects climate and how the energy is received from the sun. Near the poles the sun's energy is spread thinly over a large area. Near the equator, the sun's energy is spread out less. Here the sunlight is more direct.
- Large bodies of water will affect the climate for a particular area. Water heats up and cools down more slowly than land. Usually coastal areas are in warmer in summer and cooler in winter. Sea breezes and warm ocean currents play a role.
- The presence of mountains will affect the climate of a given area. It's cooler up higher (less air molecules to absorb heat). The ***windward*** sides of mountains are wetter (wind, moisture, rain). On the ***leeward*** side of mountains (no wind) air heats up and dries things out. As moist air is pushed up a mountain, it cools. Cool air cannot hold water as well as warm air so condensation occurs. At some point, precipitation follows.
- Seasons affect climate and the way energy is received by the Earth. Summer – more direct radiation (tilt toward the sun). Winter – less radiation (tilt away from the sun). Fall and spring – equal distribution of radiation.

Water/Precipitation in the atmosphere comes in several forms:

- ***Hail*** – lumps of ice, formed by rain drops that get blown back up into the cloud, freezes, accumulates layers of rain, drops down, gets blown back up into the cloud by strong updrafts, continuing the freezing, blowing back up, layering until the weight is greater than the force of the air blowing back up into the cloud when it falls as hail. Depending on how may 'blow back' trips it makes, it could get very large. High wind storms tend to produce hail.
- ***rain*** – liquid drops, temperatures are above freezing all the way through the atmosphere
- ***snow*** – water vapor changes directly to a solid
- ***sleet*** – freezes, melts, then re- freezes in below freezing lower atmosphere
- ***freezing rain*** – freezes, melts, then re-freezes upon contact with freezing temperatures at the surface

Humidity and factors that affect it…

- ***Relative humidity*** is a measure of the amount of water vapor in the air compared to the total amount of water that the air can hold at that temperature.
- ***Saturated*** = 100% humidity at that temperature.
- The ***dew point*** is the temperature at which the air is saturated and condensation occurs.
- Cooler temperature = less humidity (water vapor is able to condense into clouds).
- Higher temperature = more humidity (water vapor is unable to condense into clouds due to faster motion of molecules).

Key Vocabulary: climate, dew point, freezing rain, hail, leeward, mountain, relative humidity, saturated, season, sleet, snow, warm, water, weather, windward

Part Five: Miscellaneous Weather Information

Miscellaneous weather info…

- ***Pressure*** systems occur when masses of air molecules push down from above. High Pressure – air descends difficult for clouds to form (usually NICE Weather). Low Pressure – air rises and clouds form (BAD Weather)
- A ***cloud*** is a visible collection of tiny water droplets or ice crystals suspended in the air. Clouds form as warm air rises, is cooled below its dew point, and condenses. When humidity reaches 100%, water vapor condenses around nuclei (dust, salt, smoke in the atmosphere). Drops of water are so small, they are suspended in the air. Millions of these tiny water drops make a cloud. Clouds also act as heat traps.
- If air movement is mainly horizontal, clouds form in layers. These are called ***stratus*** clouds. If air movement is mainly vertical, clouds grow upward in great piles. These are called ***cumulous*** clouds. A ***cirrus*** cloud is a feathery cloud. They are so high that they are always made of ice crystals. Stratus means sheet like, Cirrus- wispy, curly, Nimbo – rain, Cumulus – heaped, piled.
- Air is a mixture of gases. Pressure is the result of collisions of air molecules with objects, and with each other. **Pressure** = force/area Changes in atmospheric pressure result from changes in: temperature, moisture content, and elevation.
- Atmospheric temperature changes from layer to layer. Gases expand when they are heated and contract when they are cooled. As a result, hot air is less dense than cool air. Increasing air temperature decreases atmospheric pressure. Decreasing air temperature increases atmospheric pressure.
- Water vapor is lighter than nitrogen and oxygen, so adding water vapor makes air lighter; the pressure underneath is lowered.
- Air has weight because gravity pulls air molecules toward the earth's surface. Near the ground, the air pressure is greater due to the weight of many air molecules pressing down from above. At higher elevations, there is less air to press on a given area. ***Air pressure*** is less at higher elevations. Air pressure is greatest at

sea level. It is measured in ***millibars*** or in inches of mercury. The standard ***atmosphere*** is equal to 1013.25 millibars.

- Wind is caused by an uneven heating of earth's atmosphere causing pressure differences. Air ALWAYS moves from high to low pressure creating a circulation. ***Sea breezes*** come from the sea during the day. Warm air over land is pushed up by cooler air coming in off of water creating a convection current. ***Land breezes*** come from the land at night. Warm air over sea is pushed up by cooler air coming from the land creating a convection current. Mountain breezes move down the mountain at night. Valley breezes move up the mountain in the morning.
- The ***Coriolis Effect*** causes a change in wind direction. It causes cold moving air from the poles to move toward the west. The Coriolis Effect is the effect of earth's rotation on the movement of air masses. North of the equator wind deflects to the right. South of the equator wind deflects to the left
- ***Trade*** Winds occur from the equator to 30° latitude. Prevailing ***Westerlies*** occur from 30° to 60° latitude. Polar ***Easterlies*** occur near poles (90° degrees latitude). ***Doldrums*** blow near the equator they are very light and constantly shifting. They make ship navigation difficult.
- ***Jet Streams*** are narrow belts of strong winds that blow near the top of the troposphere. There is one on each side of the prevailing westerlies in both hemispheres. They have an average wind speed of 97 to 185 kph. The position changes in latitude day to day and season to season. The Jet Stream affects weather patterns and air travel.
- ***Station models*** are used to represent weather information in a very compact format.

Key Vocabulary: air pressure, atmosphere, cirrus, cloud, Coriolis Effect, cumulous, doldrums, easterlies, jet stream, land breeze, millibar, pressure, sea breeze, station model, stratus, trade, westerlies

Part Six: Severe Weather Occurrences

Severe weather types:

- ***Thunderstorms*** (heavy rain, lightning, thunder, hail- cumulonimbus clouds) develop at warm moist air masses along a fast moving cold front.
- ***Tornadoes*** (funnel clouds): violent, whirling wind moving over a narrow path of land (water spout if it occurs over water) form along fronts with wind up to 500 km per hour. Their strength is classified by their wind speeds using the ***Enhanced Fujita Scale*** (EF): EF0 is the weakest, EF5 is the strongest.
- ***Hurricanes*** (typhoons or cyclones in other oceans): large, swirling, low pressure system form over tropical oceans. The winds must be at least 120 km per hour to be considered a hurricane (under 120 kph = tropical depression or storm). Their strength is classified based on the wind speeds using the ***Saffir-Simpson Scale***: Category 1 is the weakest, Category 5 is the strongest.
- Winds, in general, can be measured on the ***Beaufort Scale***. The scale ranges from 0, which is a dead calm to a 12 which is hurricane conditions.

Key Vocabulary: Beaufort Scale, Enhanced Fujita Scale, hurricane, Saffir-Simpson Scale, thunderstorms, tornado

Part Seven: Instruments and Forecasting

Meteorologists study weather. ***Station models*** are a combination of symbols used to show current weather conditions.

- ***Isotherms*** are lines connecting points of equal temperature.
- ***Isobars*** are lines connecting points of equal pressure.

Meteorologists use various instruments to measure weather data…

- ***Psychrometer*** (or hydrometer) is used to measure humidity
- ***Barometer*** – atmospheric pressure
- ***Thermometer***- air temperature
- ***Anemometer*** – wind speed
- ***Weather vane*** – wind direction
- ***Rain gauge*** – amount of precipitation

Key Vocabulary: anemometer, barometer, isobar, isotherm, psychrometer, rain gauge, station model, thermometer, weather vane

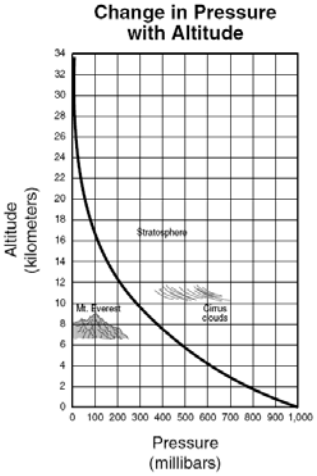
Part Eight: Effects of Human and Geologic Activity

Human activities such as burning fossil fuels have increased CO_2 levels. High CO_2 levels produce the ***greenhouse effect***. CFC's are decreasing the ozone levels of the upper atmosphere. ***Ozone*** blocks harmful UV radiation.

Key Vocabulary: greenhouse effect, ozone

Sample SOL Questions

1. The chart shows the relationship between altitude and air pressure. What is the approximate air pressure at an altitude of 22 kilometers?



F 40 millibars **G** 120 millibars **H** 200 millibars **J** 400 millibars

2. Moist air from the Pacific Ocean rises and cools as it passes from west to east over the Sierra Nevada Mountains. Once it is over the mountain range, the air descends and warms on the other side. What is the result of the air ascending, then descending over the mountains?

F Desert on the west side of the mountains and heavy rains on the east side
G Heavy rains on the west side of the mountains and desert on the east side
H Heavy rains on the west side of the mountains and year-round snow on the east side
J Desert on the east and west sides of the mountains and heavy rains on top of the mountains

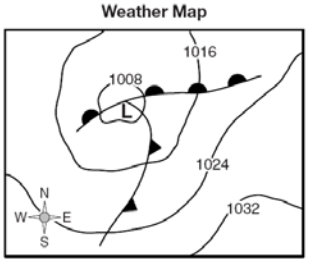
3. Which of the following was primarily responsible for the development of life outside of the oceans?

F A decrease in atmospheric hydrogen
G A decrease in atmospheric carbon dioxide
H An increase in atmospheric nitrogen
J An increase in atmospheric oxygen

4. On weather maps, there are lines with tiny triangles on one side. This represents —

F cold air moving in the direction the triangles point
G cold air moving opposite the direction the triangles point
H warm air moving in the direction the triangles point
J warm air moving opposite the direction the triangles point

5. The label L on the map on the right indicates an area of low —



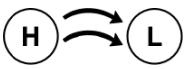
A temperatures **B** pressure **C** altitude **D** rainfall

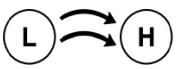
6. People have tried many methods to artificially produce rain. One method, called cloud seeding, involves airplanes dropping particles of silver iodide onto clouds to help the clouds produce rain droplets. These silver iodide particles act as —

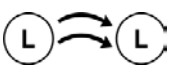
A hailstones **B** dew points **C** electrical charges **D** condensation nuclei

7. Which diagram correctly shows wind motion between pressure areas?

A 

B 

C 

D 

8. Which of these is likely to occur after moist air is cooled below its dew point?

A Water condenses. **B** Evaporation increases. **C** Ice crystals melt. **D** Winds are generated.

9. Dramatic variations in the polar ice caps most likely suggest changes in —

F the Moon's orbit **G** Earth's climate **H** ebb and flow of tides **J** global water consumption

10. Water vapor is lighter than many atmospheric gases such as oxygen, nitrogen, and carbon dioxide. Why then doesn't water vapor rise above these other gases to a higher level of the atmosphere?

A Water vapor contains other elements that give it weight.
B The cool atmosphere condenses the rising water vapor and causes it to fall back to Earth.
C The water molecules are attracted to molecules of heavier gases and remain in the lower regions of the atmosphere.
D There is an attraction among the water vapor molecules to hold them together close to the Earth.

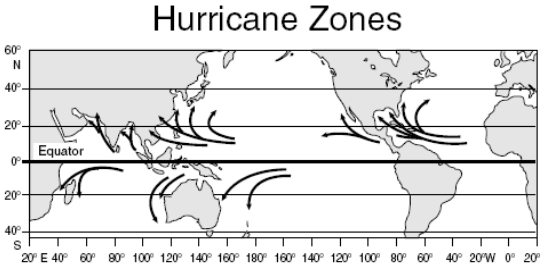
11. On clear nights in late summer and early fall in the Shenandoah Valley, why does ground fog form in the low areas near the Shenandoah River?

F Cool, descending air meets moist air in the low areas near the river.
G Cool, moist air ascends from the river to the hilltops.
H Warm winds bring moisture from the hills down into the valley.
J There is more air pollution in the evenings.

12. Cloudy nights can be warmer than clear nights because clouds trap heat —

F generated from tropical winds
G produced by the friction of air particles
H released from Earth's interior
J absorbed by Earth during daylight hours

13. According to the map, most hurricanes occur where —



F the oceans are warmest.
G the landmasses are largest.
H the atmosphere is driest.
J areas of greatest population exist.

14. Based on the changes between the weather conditions as seen in the table on the right, which of these most likely passed by the weather station between time 1 and time 2?

A Thunderstorm
B Low pressure area
C Cold front
D Warm front

Conditions at Time 1

Temperature	30°C
Pressure	996 mb
Wind direction	From the south
Precipitation	None

Conditions at Time 2

Temperature	25°C
Pressure	1010 mb
Wind direction	From the north
Precipitation	None

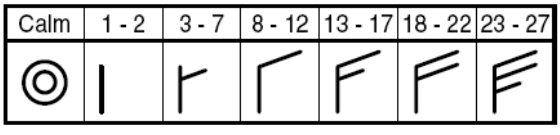
15. Most water leaves the ocean through evaporation and returns to the ocean through —

A surface runoff
B ground water
C transpiration
D precipitation

16. Based on the symbols shown, which of the following represents a wind speed of 30 knots?

A 
B 
C 
D 

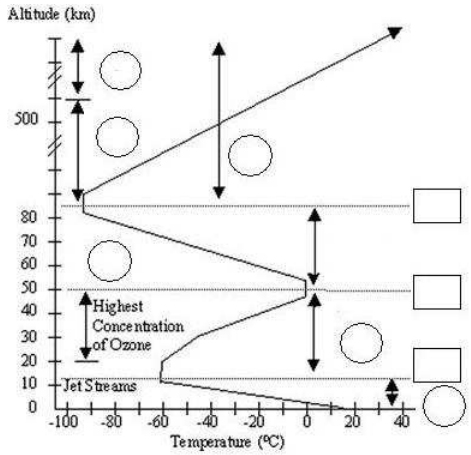
Wind Speed (in knots)



Application

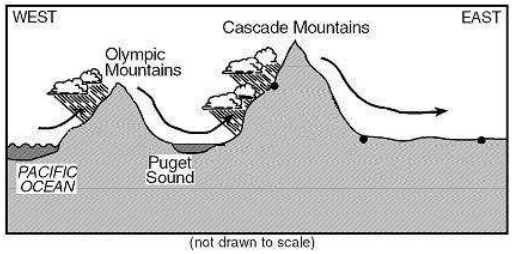
One the following pages, you will find diagrams to label, information to be completed or questions to be answered. Please complete the pages accurately and study the information contained there.

Layers of the Atmosphere:
Use the space below the pictures to label the layers and the pauses. The circles are the layers and the boxes are the pauses.



___ exosphere
___ ionosphere
___ mesopause
___ mesosphere
___ stratopause
___ stratosphere
___ thermosphere
___ tropopause
___ troposphere

Orographics: Describe why the rains only occur on the west side of these mountains.



_____

_____

_____

Human Impacts to the Atmosphere:
List some ways the atmosphere is impacted by the following things.

Volcanoes – _____

_____

Meteorites – _____

_____

Humans – _____

_____

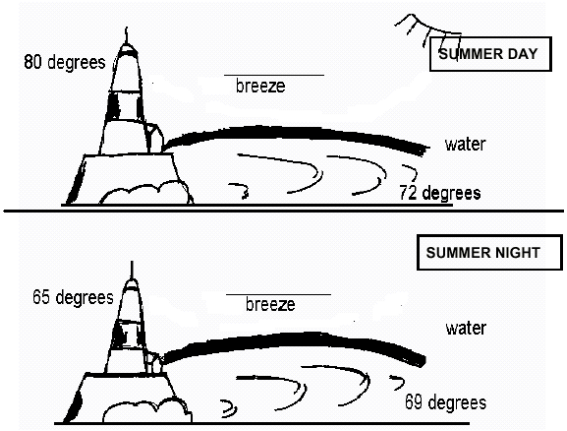
Humans – _____

_____

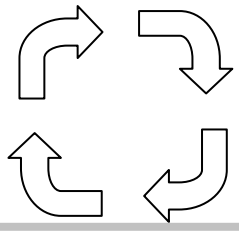
Humans – _____

_____

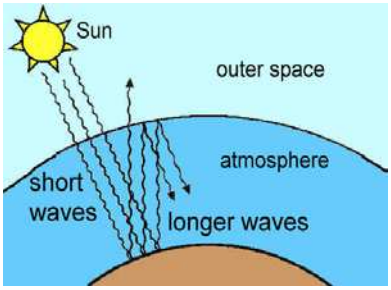
Land Breezes/ Sea Breezes:
On the diagrams below, determine which picture is a land breeze and which is a sea breeze. Label it on the line above the word 'breeze'. Also show the direction of air movement AND where the high and low pressure areas are the cause the winds to blow.

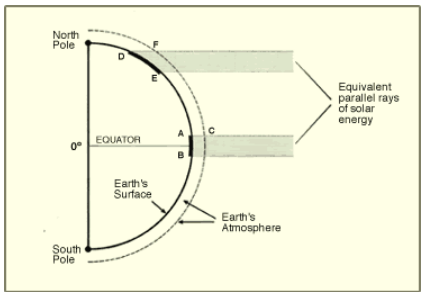


Use this set of arrows to show how air currents move. Color the warm currents red and the cold currents blue. Put an "H" where the pressure is high and an "L" where the pressure is low.



Solar Heating of the Atmosphere: Label this diagram with the percentages that are absorbed by Earth, the atmosphere and the amount reflected back out to space.





Discuss why this diagram explains why temperatures are warmer at the equator than at the poles.

_____

_____

Precipitation:
Describe the formation for each of these types of precipitation. Descriptions should include what parts of the atmosphere are above or below the freezing point.

Hail – _____

_____

Sleet – _____

_____

Snow – _____

_____

Rain – _____

_____

Freezing Rain – _____

_____

Severe Weather:
Describe the types of severe weather indicated below. Descriptions should include how each is formed and how each is measured.

Thunderstorms – _____

_____

_____

Hurricanes – _____

_____

_____

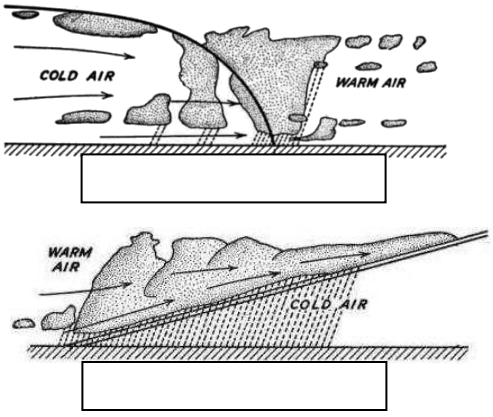
_____

Tornadoes – _____

_____

_____

Fronts: Identify the two types of fronts shown here.



Add symbols to the lines on the left to indicate the 4 types of fronts. Additionally, write a brief description of what the weather is like as each front is present and passes.

_____ Front – _____

_____

_____ Front – _____

_____

_____ Front – _____

_____

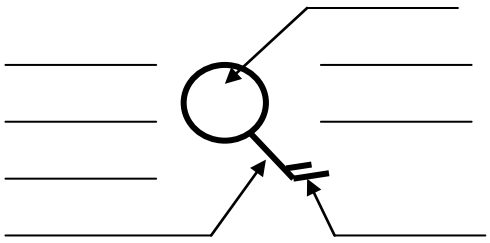
_____ Front – _____

_____

Air Masses: Complete the table below with the appropriate information about air mass characteristics (warm or cold, moist or dry and where it forms). Color the words to help you remember. Color 'Very Cold' purple, 'Cold' blue, 'Warm' red, 'Dry' brown, and 'Moist' green.

Air Mass Name	Abbr.	Temp. / Moisture	Forms over…
		/	
		/	
		/	
		/	
		/	

Weather Map Symbols: Indicate what each location is used for on a Weather Station Model. Complete the remaining definitions/information requested.



Isobar – _____

_____

Isotherm – _____

_____

Draw the symbols for the follow (as seen on a station model):

Rain Snow Drizzle T-Storm

Astronomy and Space Science

(ES. 4 a-d, 11 a, 12 c; 13 d, 14 a -e)

ES.4 The student will investigate and understand the characteristics of the Earth and the solar system. Key concepts include:

- ☐ a) position of the Earth in the solar system;
- ☐ b) sun-Earth-moon relationships (seasons, tides, and eclipses);
- ☐ c) characteristics of the sun, planets, their moons, comets, meteors, and asteroids;
- ☐ d) the history and contributions of the space program.

ES.11 The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include:

- ☐ a) physical and chemical changes (tides, waves, currents, sea level and ice cap variations, upwelling, and salinity concentrations);

ES.12 The student will investigate and understand the origin and evolution of the atmosphere and the interrelationship of geologic processes, biologic processes, and human activities on its composition and dynamics. Key concepts include:

- ☐ c) comparison of the Earth's atmosphere to that of other planets;

ES.13 The student will investigate and understand that energy transfer between the sun, Earth, and the Earth's atmosphere drives weather and climate on Earth. Key concepts include:

- ☐ d) weather phenomena and the factors that affect climate including radiation and convection

ES.14 The student will investigate and understand scientific concepts related to the origin and evolution of the universe. Key concepts include:

- ☐ a) nebulae;
- ☐ b) the origin of stars and star systems;
- ☐ c) stellar evolution;
- ☐ d) galaxies;
- ☐ e) cosmology (the Big Bang).

Essential Questions

You should be able to answer the following question with confidence about this topic.

- ☐ Scientists use maps, instruments, models, charts, technology and imagery to explain the origin and evolution of the universe. Describe some of these maps, instruments, models, charts, technology and imagery that are used to explain the origin and evolution of the universe.
- ☐ Sun, earth and moon interact to create events such as the seasons, eclipses and tides. How does scientific evidence support the theory that the universe is constantly changing?
- ☐ How do the sun, earth and moon interact to create events such as the seasons, eclipses and tides?
- ☐ The unique characteristics of the celestial bodies are the result of the organization of the solar system. How does the location of a body in the solar system determine its characteristics?
- ☐ Space exploration and technological advances have increased knowledge of the universe. In what ways have space exploration and technological advances increased knowledge of the universe?

Part One: The Solar System

There are two groups of planets in our solar system. According to the International Astronomical Union (the organization responsible for naming ANYTHING in the heavens, the new definition for planet is "A "***planet***" is an object in orbit around the Sun that is large enough (massive enough) to have its self-gravity pull itself into a round (or nearly round) shape. In addition a "planet" orbits in a clear path around the Sun – there are no other bodies in its path that it must sweep up as it goes around the Sun."

- The Inner Planets are closest to the sun. These planets are solid, rocky, dense, and small. They are referred to as ***terrestrial*** planets. The Inner Planets are: Mercury, Venus, Earth, and Mars.
- The Outer Planets are farther from the sun. The first four of these planets are ***gaseous***, and are less dense and large. The Outer Planets are: Jupiter, Saturn, Uranus, Neptune, and Pluto. Although Pluto is an outer planet, it is the smallest planet and it is a rocky planet. It was recently 'demoted' to dwarf planet status.
- Between Mars and Jupiter is the asteroid belt. ***Asteroids*** are rocky or metallic iron objects ranging in size from millimeters to kilometers. Tens of thousands of asteroids orbit harmlessly in a region referred to as

the ***asteroid belt*** but on occasion, they will collide, sending one or both into odd orbits that may interfere with the orbit of a planet.

- The ***Solar Nebula Theory*** states that debris left over from the beginning of the universe condensed to form the Sun and the planets. The ***solar system*** consists of the Sun and all of the objects that are gravitationally bound to it.

There are numerous other objects and regions of objects in the solar system.

- Past the orbit of Pluto is the ***Kuiper Belt***. It is a region similar to the asteroid belt. It is now considered that Pluto is actually a Kuiper Belt object.
- The ***Oort Cloud*** is a region past the Kuiper Belt and it is believed that comets originate here. A ***comet*** is a mass of frozen gasses, dusts and rock particles. They orbit the Sun in a regular period. The tail of a comet always faces away from the Sun due to the solar winds coming from the Sun. Sometimes, they cross the path of Earth's orbit. When Earth goes through the debris stream from the remnants of a comet, we have a meteor shower. We will go through that same debris trail every year.

There are other objects that interact with Earth. They are meteoroids, meteors and meteorites.

- A ***meteoroid*** is a small rocky object that travels in space. It is generally considered to be much smaller than an asteroid.
- A ***meteor*** is a meteoroid that enters Earth's atmosphere and burns up.
- A ***meteorite*** is a meteor that doesn't completely burn up and strikes the Earth..

There are two major measurements used in astronomy.

- An ***astronomical unit*** (AU) is the average distance between the Sun and the Earth. This is approximately 93 million miles.
- A ***light year*** (LY) is the distance light travels in one year. This distance is approximately 9.5 trillion miles.

Key Vocabulary: asteroid, asteroid belt, astronomical unit, comet, gaseous, Kuiper Belt, light year, meteor, meteorite, meteoroid, Oort Cloud, planet, Solar Nebula Theory, solar system, terrestrial

Part: Two: Sun-Earth-Moon System

When a satellite travels around another object, this is called ***revolution***. ***Rotation*** is the word used to describe a satellite turning on its axis.

- The Earth completes one revolution, or one orbit, around the sun every year (365 days, 6 hours, and 9 minutes).
- The Earth completes one rotation, or turn on its axis every day (23hours, 56 minutes). An axis is an imaginary line on which an object spins.
- Our moon rotates, or spins on its axis once every 29.5 days.
- Our moon revolves around the Earth once every 27.3 days.
- It takes the same amount of time for the moon to rotate and revolve, so the same side of the moon always faces the Earth. The difference in days between rotation and revolution has to do with the fact that the Earth is also revolving around the Sun and is farther in its orbit when the moon makes one complete revolution.
- The moon is tidally locked to the Earth…meaning the same side of the moon always faces the earth. There is one side of the moon that we never see. This is called the "Far Side of the Moon".

The moon is a natural satellite of Earth.

- The moon shines due to Sun reflecting off of its surface. This causes the ***phases*** of the moon.
- When there is a ***new moon***, the lighted side of the moon can't be seen from Earth.
- When there is a ***full moon***, the entire lighted side of the moon can be seen.
- When there is a small sliver of the lit side visible from Earth it is a ***crescent*** phase.
- When one half of what we see from Earth is lit it is a ***quarter*** phase.
- When most, but not all, of what we see from Earth is lit it is a ***gibbous*** phase.
- The ***waxing*** phases occur when just after a new moon, more and more of the lighted side of the moon can be seen. The moon appears to change from all dark to all light.
- The ***waning*** phases occur when just after a full moon, less and less of the lighted side of the moon can be seen. The moon appears to change from all light to all dark.
- In order, the moon phases are new moon, waxing crescent, first quarter, waxing gibbous, full moon, waning gibbous, third or last quarter, waning crescent and back to the new moon.
- Two mnemonics to help you remember what the phases are as well as the difference between waxing and waning: 1) When the light is on the right, the moon is getting bright. 2) Waxing is maxing and waning is draining.
- A ***lunar*** eclipse occurs when the Earth moves between the sun and the moon.
- A ***solar*** eclipse occurs when the moon moves between the Earth and the Sun.

Tides are caused by the gravitational pull of the moon and sun on the ocean. A tidal change is actually a wave.

- *Spring* tide causes high tides that are especially high and low tides that are especially low.
- *Neap* tide causes high tides that are not very high and low tides that are not very low.
- The *tidal range* is the difference in levels between high tide and low tide.

Some final terms associated with the Earth-Sun-Moon relationship…

- A *season* is a regular, short-term period of change in the climate of an area due to changes in the amount of solar radiation the area receives.
- Seasons have NOTHING to do with how close we are to the Sun.
- Seasons are caused by: the revolution of Earth around the Sun, the *tilt* of the Earth's axis, and the parallelism of the Earth's *axis*.

Key Vocabulary: axis, crescent, full, gibbous, lunar, neap, new, phases, quarter, revolution, rotation, season, solar, spring, tidal range, tide, tilt, waning, waxing

Part Three: Sun

Our solar system's star is the Sun. It is a middle aged star and is about 4.5 to 5 billion years old. It should continue for another 4.5 to 5 billion years. The Sun has 4 main layers and there are a few surface features that are important.

- The *core* is in the center of the sun and is where nuclear fusion occurs. It is the most dense portion of the star and its temperature is about 15 million degrees Celsius.
- There is an area between the core and the atmosphere where *convection* moves energy from the center of the sun to the surface.
- The atmosphere of the sun is made up of 3 parts. The *photosphere* is the brightest and lowest layer of the atmosphere. It is the layer we see. The next layer out is the *chromosphere* and it cannot be seen because of the brightness of the photosphere. The outer most layer of the atmosphere of the sun is the *corona*. It can only be seen during an eclipse. From the corona, *solar wind*s eject material from the sun into space.
- There are 3 main surface features found on the sun as well as any other star. A *flare* is where an eruption on the surface occurs and massive amounts of material are flung into space. A *prominence* is similar to a flare except that because of magnetic field lines on, the flare arches back down to the surface. Finally, *sunspots* are cool, dark regions on the surface that are usually found near prominences and are related to magnetic field lines.

Key Vocabulary: chromosphere, convection, core, corona, flare, photosphere, prominence, solar wind, sunspot

Part Four: Stars

Stars are a large dense concentration of hydrogen gas, *fusion* in the core causes two hydrogen atoms to form helium.

- A *constellation* is a group of stars that form a pattern. The Big Dipper is an example of a constellation.
- Stars follow a definite development/destruction pattern that is referred to as the *life cycle of a star*. There is a graph called the *Hertzprung-Russell Diagram* (also called the H-R Diagram) which charts stars based on their temperature, luminosity, magnitude and mass.
- A star forms from a spinning cloud of gas and dust called a *nebula*. As the nebula spins, gravity causes it to shrink. The spinning nebula flattens into a disk of dust and gas.
- Material comes together at the center of the disk. A *protostar* begins to form. A protostar is the material in the center of a nebula that becomes a star. The protostar shrinks. As it shrinks, temperature and pressure build up. When the temperature and pressure are high enough, the protostar starts to give off light and heat. It is now a star.
- The most stable phase of stellar life is when it is in the *main-sequence stage*. This is considered the middle age of the life span of a star and it spends most of the time in this stage. Our star is a main-sequence star.
- The ultimate life span of the star depends on its mass. Larger mass stars (30 or more times the size of the Sun) will eventually swell to a *supergiant*. From there, the star will explode as a *supernova*. After the supernova stage, the remaining matter collapses into an extremely dense ball and becomes a *neutron* star and then a *black hole*.
- Stars that are sun-sized will swell into a *red giant*, explode into a *nova* and ultimately collapse into a *white* dwarf or a *black* dwarf.
- *Parallax*- the apparent shift in the position of an object when viewed from two different positions.

Key Vocabulary: black, black hole, constellation, fusion, H-R Diagram, life cycle of stars, main-sequence, nebula, neutron, nova, protostar, red giant, supergiant, supernova, white dwarf

Part Five: Galaxies

In the 1920s, an American astronomer, Edwin Hubble observed some fuzzy patches of light in the sky. He discovered that these patches of light were galaxies, made up of millions or billions of stars.

- Galaxies are made up of billions of stars. It is estimated that there are over 100 billion galaxies in the universe.
- Galaxies are classified according to their shape. Edwin Hubble developed the ***Hubble Tuning Fork*** diagram to aid in their classification.
- ***Spiral*** galaxies are made up of a ***central core*** or ***nucleus*** (which usually contains a supermassive ***black hole***) with areas of stars resembling ***arms*** coming off of the central core. Spiral galaxies have many young stars and star forming regions.
- ***Barred spiral*** galaxies also have a central core but there is a bar of stars that come out of the core and the arms only come from the ends of the bars.
- ***Elliptical*** galaxies have a central core but no arms. The stars are spread out evenly around the core. These galaxies may be nearly circular or very elliptical (oval) in shape. They are mostly made up of old stars.
- ***Irregular*** galaxies have no central core, no arms and no organized shape. They tend to be smaller than spirals and ellipticals.
- Our solar system is located in the ***Milky Way*** galaxy.

Key Vocabulary: arms, barred spiral, black hole, central core, elliptical, Hubble Tuning Fork, irregular, Milky Way, nucleus, spiral

Part Six: History and Contributions of the Space Program

A body that orbits a larger body is called a satellite. A moon is considered to be a natural satellite. However, since the space program began in the 1950's, there have been many man-made satellites orbiting Earth, both manned and unmanned.

- In 1957 the former Soviet Union launched Sputnik 1, the Earth's first artificial satellite (remember the movie *October Sky*?).
- In 1958, the United States launched its first Satellite, Explorer 1. The first spacecraft to leave Earth and reach lunar (around the moon) orbit was part of the Luna series of space probes launched by the former Soviet Union.
- At the same time that the Luna series was in progress, the United States launched the Pioneer space probes.
- On July 20, 1969, ***Apollo 11*** astronauts ***Neil Armstrong*** and ***Edwin 'Buzz' Aldrin Jr.***, became the first people to walk on the moon. Between 1969 and 1972 the United States sent six Apollo spacecraft to the moon. A total of 12 people have walked on the moon…2 per successful mission.
- Pioneer, Mariner, Voyager, and Venera are the names of some of the spacecraft launched from Earth to explore the solar system in the 1970's and 1980's.
- The Space Shuttle program began in April 1981, restarting manned space flight. Since then, there have been over 100 shuttle missions. Many of the shuttle missions were designed to perform rescue and repair missions for satellites already in orbit.
- More recent probes include Spirit, Opportunity and Phoenix which are currently exploring Mars, Cassini and its probe, Huygens, are currently exploring Saturn, Messenger is currently exploring Mercury and New Horizons is on its way to Pluto and should arrive in 2015…it left in 2007! It will be the first probe sent to Pluto.

Key Vocabulary: Apollo 11, Edwin (Buzz) Aldrin, Neil Armstrong

Part Seven: Origin and Evolution of the Universe

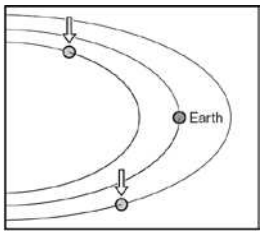
Using the Doppler Effect, Edwin Hubble and other astronomers saw that the galaxies were ***redshifted*** which means they are moving away from each other. In other words, the universe is expanding. Astronomers needed a theory to explain this observation. Today scientists have a theory called the ***Big Bang Theory***. The "Big Bang" Theory is a leading theory for the formation of the universe. According to this theory, approximately 15 billion years ago the universe began expanding out of an enormous explosion. The galaxies are still flying away from the point of the big bang. After the big bang, the matter in the universe started to condense and form galaxies. Galaxies are systems containing millions or even billions of stars. We live in the Milky Way, which is a part of a small cluster of 17 galaxies called the local group.

Key Vocabulary: Big Bang Theory, redshift

Sample SOL Questions

Written and assembled by D. L. Edwards with input from other valued teachers throughout Virginia. Strasburg High School, Strasburg, VA, May/June, 2008; Revised May 2010

1. **When Venus passes between the Earth and the sun, it is visible as a tiny black dot on the sun's bright disk. Why is Mars never visible in this same way?**

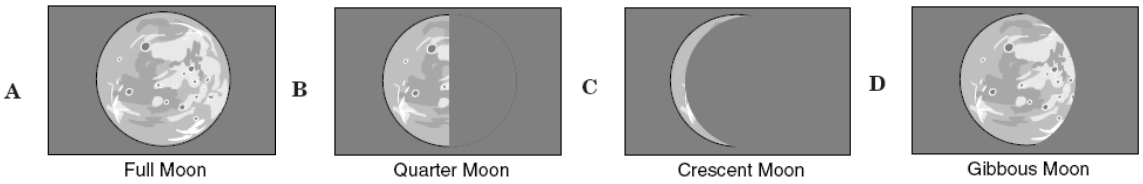


F The orbit of Mars is more eccentric than that of Venus.
G The orbit of Mars is outside that of the Earth's orbit.
H Mars is too small to be seen against the backdrop of the sun.
J Mars shines too brightly to be visible against the sun.

2. **In addition to Earth's orbit, which planets' orbits are shown?**

F Mars and Jupiter **G** Jupiter and Saturn **H** Venus and Mars **J** Mercury and Venus

3. **During which of these phases of the moon will the tides be highest?**



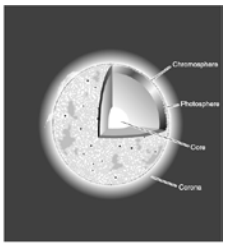
4. **The sun emits energy by converting hydrogen into helium. What is this process called?**

F Fusion **G** Fission **H** Sunspot formation **J** Solar wind

5. **In 1912, an astronomer at Arizona's Lowell Observatory noticed that the lines in the spectra of most galaxies shifted toward the red end of the spectrum. Another American astronomer, Edwin Hubble, later interpreted this discovery as evidence that —**

F galaxies were once part of one huge megagalaxy
G an explosion will one day result from the pressure building as the galaxies expand
H galaxies are moving away from each other in a constantly expanding universe
J the largest galaxies are slowly engulfing their smaller neighbors

6. **Which layer of the sun is the most dense?**

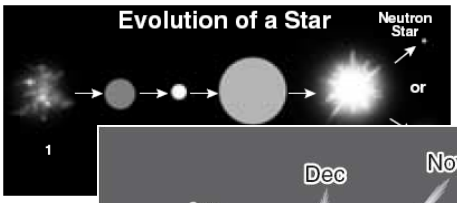


F Chromosphere **G** Photosphere **H** Core **J** Corona

7. **The first manned-mission to land on the moon was commanded by Neil Armstrong and was called —**

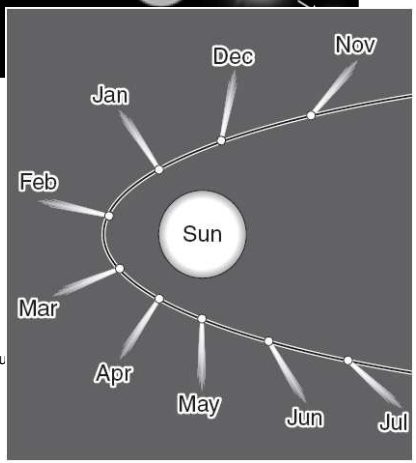
F Apollo 11 **G** Gemini 3 **H** Viking 2 **J** Mariner 7

8. **Which of the evolutionary stages of a massive star shown here is called a supernova?**



F 1 **G** 2 **H** 3 **J** 4

9. **Which of these facts is the best supporting evidence that the universe is expanding?**



A The stars vary in chemical composition.
B The galaxies are moving away from each other.
C The galaxies can spin to form eddies.
D The universe is filled with galaxies of different sizes.

10. **Why does a comet's tail point away from the Sun?**

A The solar wind blows the tail away from the Sun.
B It is being pulled by a nearby black hole.
C The Moon's light only shines on part of the comet.
D The comet's tail is following the path of Jupiter.

11. Which of these planets has the smallest diameter and the greatest average density?

F Neptune **G** Jupiter **H** Saturn **J** Mercury

12. Which of these best describes the composition of a nebula such as the Crab Nebula?

F Large asteroids
G Clouds of dust and gas
H Ice crystals
J Planets and moons

13. Which of these measurements allows scientists to compare the brightness of stars?

A Absolute magnitude **B** Critical density **C** Orbital velocity **D** Red shift

14. Photographs of the surface of Mars reveal the presence of sand dunes that shift over time. These dunes demonstrate the presence of what phenomenon on Mars?

F Precipitation **G** Winds **H** Magnetic pole reversals **J** Plate tectonics

15. Orbital velocity is the average speed of a planet moving through space in its orbit around the sun. Which of the following planets has the fastest orbital velocity?

A Mercury **B** Jupiter **C** Mars **D** Pluto

16. Saturn's volume is 762 times the volume of Earth, and yet its mass is only about 95 times that of Earth's mass. This is due to Saturn's —

F low density **G** temperature **H** thousands of rings **J** distance from the sun

17. A light-year measures —

F brightness **G** distance **H** radiation **J** time

18. A star might be much brighter than it appears to be. This is called the star's absolute magnitude. The difference in apparent magnitude and absolute magnitude is due primarily to the star's —

A surface temperature
B motion through the universe
C diameter
D distance from the Earth

19. The pole star, Polaris, is nearly stationary and straight overhead when seen from the North Pole. When viewed from the Equator, it —

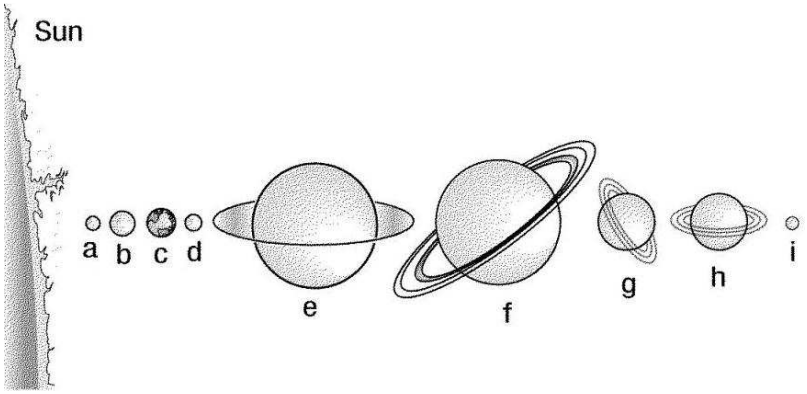
F is nearly stationary and on the horizon
G is nearly stationary and directly overhead
H rises barely above the eastern horizon, moves along the southern horizon, and sets in the West
J rises straight up in the East, passes directly overhead, and descends straight down in the West

Application

One the following pages, you will find diagrams to label, information to be completed or questions to be answered. Please complete the pages accurately and study the information contained there.

Written and assembled by D. L. Edwards with input from other valued teachers throughout Virginia. Strasburg High School, Strasburg, VA, May/June, 2008; Revised May 2010

Planets in Our Solar System: Complete the table below with the requested information about the planets in our solar system. Use the diagram below to help you complete the table. Also, show the location of the asteroid belt.



Define these 2 key theories.

Big Bang – _____

_____

_____

_____

Solar Nebula – _____

_____

_____

#	Planet Name	Terrestrial or Gaseous	# of Moons	Composition of Atmosphere	1 Key Fact
1					
2					
3					
4					
5					
6					
7					
8					
9					

Galaxies: In the space on the right, describe the galaxy type. In the space on the left, draw a picture of it.

Picture	**Galaxy type**
	Spiral –
	Barred Spiral –
	Elliptical –
	Irregular –

Other things in space: Define the terms below.

Comet – _____

_____

Asteroid – _____

_____

Meteoroid – _____

_____

Meteor – _____

_____

Meteorite – _____

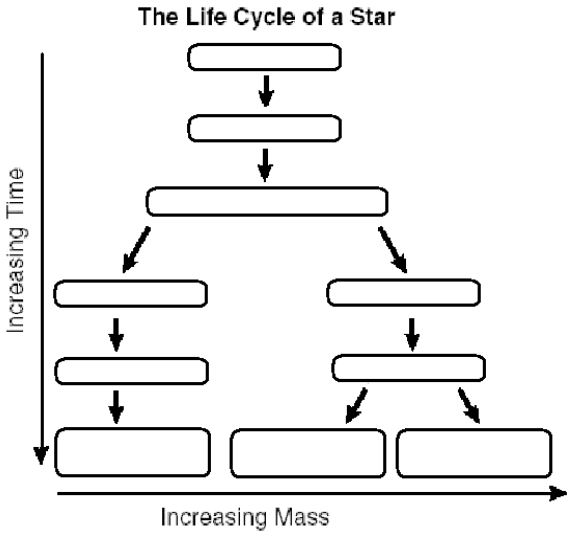
_____

Telescopes: Describe and sketch the two major types of telescopes indicated below.

Refracting Telescope

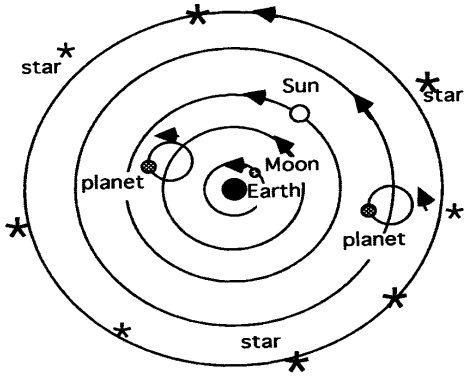
Reflecting Telescope

Stages in Star Formation: Fill in the blanks using the terms or the letter for that term listed below the diagram.

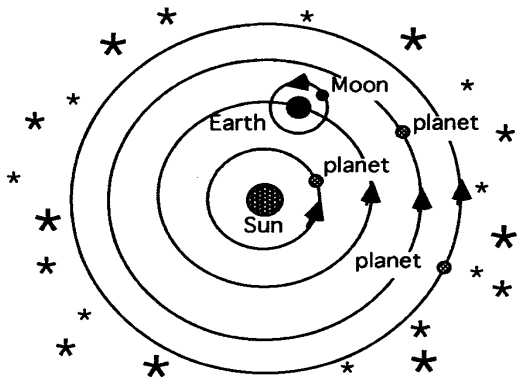


a. black dwarf
b. black hole
c. main-sequence
d. nebula
e. neutron star
f. protostar
g. red giant
h. supergiant
i. supernova
j. white dwarf

History of Astronomy: The two diagrams below model two different theories of the order of the objects in the solar system. Place the name below the model.

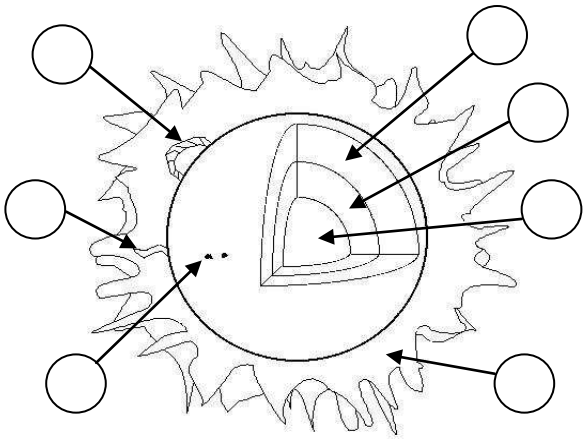


_____



_____

Solar Features: Using the letters with the terms, match the features in the diagram to their term.



a. chromosphere
b. core
c. corona
d. flare
e. photosphere
f. prominence
g. sunspot

Ancient Astronomers: Next to the name of each of the early astronomers, state one major contribution they made to our understanding of astronomy.

Nicolaus Copernicus – _____

_____

Tycho Brahe – _____

_____

Johannes Kepler – _____

_____

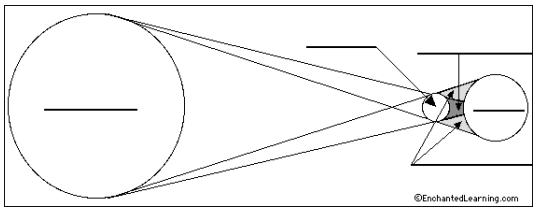
Galileo Galilei – _____

_____

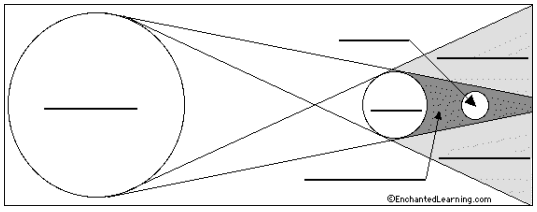
Sir Isaac Newton – _____

_____

Eclipses: Identify and label the eclipses. Use the letters for the terms below to identify the parts of the eclipses. Circle 'Solar" or "lunar" to identify the type.



Solar or Lunar?



Solar or Lunar?

(E) Earth (S) Sun (U) Umbra
(M) Moon (P) Penumbra

Concept Checks

Review the list of terms below. For each one, determine how well you understand the term or the concept that it represents after having completed the review questions on the previous pages. If you understand it thoroughly, place a check (✓) in the space next to it. If you have heard of it but are less certain about it, place a plus (+) in the space next to it. If you've never heard of it or simply can't seem to understand it, place an 'o' in the space next to it. Let the 'o' items help focus your studying.

Unit 1:Scientific Investigation

Part 1 Scientific Method
- ___ conclusion
- ___ data table
- ___ hypothesis
- ___ law
- ___ problem
- ___ procedure
- ___ research
- ___ test
- ___ theory
- ___ trial

Part 2 Variables and Constants
- ___ constant
- ___ control
- ___ dependent variable
- ___ graph
- ___ independent variable
- ___ table
- ___ x-axis
- ___ y-axis

Part 3 Measurement
- ___ gas
- ___ gram
- ___ length
- ___ liquid
- ___ liter
- ___ mass
- ___ meter
- ___ metric system
- ___ SI unit
- ___ solid
- ___ temperature
- ___ volume
- ___ weight

Part 4 Density
- ___ mass
- ___ volume
- ___ density
- ___ specific gravity
- ___ water
- ___ displacement

Unit 2: Mapping the Earth

Part 1 Latitude/Longitude/ Map Reading
- ___ bar scale
- ___ compass rose
- ___ coordinates
- ___ degree
- ___ Equator
- ___ hemisphere
- ___ International Date Line
- ___ latitude
- ___ legend
- ___ longitude
- ___ map scale
- ___ meridian
- ___ minute
- ___ parallel
- ___ Prime Meridian
- ___ representative scale
- ___ second
- ___ time zones
- ___ verbal scale

Part 2 Topographic Maps
- ___ benchmark
- ___ contour
- ___ contour interval
- ___ elevation
- ___ gentle slope
- ___ hachure
- ___ index contour
- ___ profile
- ___ steep slope
- ___ topographic map

Part 3 Global Positioning Systems
- ___ elevation
- ___ GPS
- ___ latitude
- ___ longitude
- ___ satellite
- ___ waypoint

Unit 3: Minerals and Rocks

Part 1 Properties of Minerals
- ___ carbonates
- ___ composition
- ___ compound
- ___ crystal
- ___ element
- ___ inorganic
- ___ mineral
- ___ natural
- ___ silicates

Part 2 Mineral ID
- ___ acid test
- ___ cleavage
- ___ color
- ___ fracture
- ___ hardness
- ___ luster
- ___ metallic
- ___ Mohs
- ___ non-metallic
- ___ plane
- ___ specific gravity
- ___ streak

Part 3 Mineral Resources
- ___ bauxite
- ___ calcite
- ___ clay
- ___ diamond
- ___ feldspar
- ___ galena
- ___ gem
- ___ graphite
- ___ halite
- ___ hematite
- ___ hornblende
- ___ kyanite
- ___ magnetite
- ___ mica
- ___ ore
- ___ pyrite
- ___ quartz
- ___ sulfur
- ___ talc

Part 4 Rock Identification and Rock Types
- ___ basalt
- ___ cementation
- ___ clastic
- ___ coal
- ___ compaction
- ___ convergent
- ___ cooling
- ___ divergent
- ___ extrusive
- ___ foliated
- ___ fossil
- ___ gneiss
- ___ granite
- ___ gypsum
- ___ harden
- ___ heat
- ___ igneous
- ___ intrusive
- ___ lava
- ___ limestone
- ___ magma
- ___ marble
- ___ metamorphic
- ___ minerals
- ___ non-clastic chemical
- ___ non-clastic organic
- ___ non-foliated
- ___ obsidian
- ___ pressure
- ___ pumice
- ___ quartzite
- ___ rock
- ___ rock salt
- ___ sandstone
- ___ sedimentary
- ___ schist
- ___ shale
- ___ slate
- ___ volcano
- ___ water

Part 5 The Rock Cycle
- ___ cementation
- ___ compaction
- ___ conglomerate
- ___ cooling

___ deposition
___ erosion
___ hardening
___ heat
___ lava
___ magma
___ melting
___ pressure
___ rock cycle
___ sediment
___ temperature
___ weathering

Unit 4: Resources

Part 1 Renewable and Nonrenewable Resources
___ non-renewable
___ renewable
___ recycle

Part 2 Environmental Impacts of Energy Resources
___ alternative fuel
___ energy
___ geothermal energy
___ hydroelectric energy
___ nuclear energy
___ ozone layer
___ solar energy
___ wind energy

Part 3 Virginia Resources
___ anthracite
___ bituminous
___ coal
___ fossil fuel
___ lignite
___ non-renewable
___ peat
___ resource

Unit 5: Geologic Processes

Part 1 Earth's Composition
___ asthenosphere
___ basalt
___ continental crust
___ convection
___ crust
___ granite
___ inner core
___ lithosphere
___ mantle
___ oceanic crust
___ outer core

Part 2 Plate Tectonic Processes and Landforms
___ compression
___ continental drift
___ continental volcanic arc
___ convergent
___ divergent
___ faulting
___ folding
___ island arc
___ magnetic
___ mid-ocean ridge
___ Pangaea
___ plate tectonics
___ rifting
___ rift valley
___ seafloor spreading
___ shearing
___ subduction
___ tension
___ transform
___ trench

Part 3 Mountains
___ dome
___ fault-block
___ folded

Part 4 Earthquakes and Faults
___ compression
___ earthquake
___ energy
___ epicenter
___ fault
___ focus
___ foot
___ hanging
___ L
___ long
___ Mercalli
___ normal
___ P
___ primary
___ reverse
___ Richter
___ S
___ secondary
___ seismic waves
___ seismogram
___ seismograph
___ shearing
___ stress
___ strike-slip
___ surface
___ tension
___ thrust
___ wave

Part 5 Volcanoes
___ ash
___ caldera
___ cinder cone
___ composite
___ cone
___ crater
___ hot spot
___ lava
___ magma
___ magma chamber
___ neck
___ shield
___ smoke
___ steam
___ vent

Unit 6: Freshwater Processes

Part 1 Physical and Chemical Weathering
___ abrasion
___ animal activity
___ carbonation
___ chemical weathering
___ exfoliation
___ friction
___ hydrolysis
___ ice wedging
___ mechanical weathering
___ oxidation
___ plant acids
___ plant roots
___ temperature changes
___ weathering

Part 2 Soil Formation
___ horizon
___ humus
___ organic
___ parent rock
___ soil profile
___ topsoil

Part 3 Erosion and Mass Wasting
___ creep
___ deposition
___ erosion
___ landslide
___ mass wasting
___ runoff
___ slope
___ slump

Part 4 River Mechanics and Deposition
___ alluvial fan
___ bedload
___ carrying ability
___ channel
___ delta
___ cut bank
___ dissolved load
___ erosion
___ floodplain
___ meander
___ oxbow lake
___ point bar
___ saltation
___ stream piracy
___ suspended load
___ traction
___ tributary
___ v-shaped valley
___ velocity

Part 5 Glaciers
___ continental glacier
___ glaciermoraine
___ u-shaped valley
___ valley glacier

Part 6 Karst Topography
___ calcite
___ cavern
___ column
___ disappearing stream
___ karst
___ limestone
___ sinkhole
___ stalactite
___ stalagmite

Part 7 Groundwater Zones and Sources of Freshwater
___ aquifer
___ artesian well
___ condensation
___ cone of depression
___ evaporation
___ evapotranspiration

___ geyser
___ groundwater
___ hot spring
___ hydrologic cycle
___ impermeable
___ permeability
___ permeable
___ porosity
___ precipitation
___ spring
___ water table
___ zone of aeration
___ zone of saturation

Part 8 Human Usage on Water Quality
___ conservation
___ desalination

Unit 7: Historical Geology

Part 1 Fossil Formation and Type
___ amber
___ carbon film
___ cast
___ fossil
___ index fossil
___ mold
___ original remains
___ petrified remains
___ trace fossil

Part 2 Relative Dating
___ correlation
___ cross-cutting
___ fault
___ horizontality
___ igneous intrusion
___ included fragments
___ relative dating
___ superposition
___ unconformity
___ uplift

Part 3 Absolute Dating
___ absolute dating
___ carbon-14
___ daughter
___ half-life
___ parent
___ radioactive decay
___ U-238

Part 4 The Geologic Time Scale
___ Cenozoic
___ eon
___ epoch
___ era
___ Mesozoic
___ Paleozoic
___ period
___ Precambrian

Part 5 Origin of Earth's Atmosphere
___ cyanobacteria
___ ozone
___ photosynthesis

Unit 8: Virginia Geology/ Chesapeake Bay

Part 1 Virginia's Physiographic Provinces
___ Appalachian Plateau
___ Blue Ridge
___ Coastal Plain
___ coal
___ copper
___ gold
___ iron
___ lead
___ lime
___ limestone
___ methane
___ mineral
___ natural gas
___ oil
___ Piedmont
___ pyrite
___ tin
___ turquoise
___ Valley and Ridge

Part 2 The Chesapeake Bay
___ benthic
___ Chesapeake Bay
___ drainage area
___ estuary
___ James
___ marsh
___ nekton
___ non-point source
___ plankton
___ point source
___ Potomac
___ Rappahannock
___ SAV
___ Susquehanna
___ watershed
___ York

Unit 9: Oceanography

Part 1 Interacting Processes and Systems
___ convection
___ crest
___ current
___ deep zone
___ density
___ gyre
___ mixed layer
___ neap tide
___ salinity
___ spring tide
___ surface zone
___ thermocline
___ tide
___ trough
___ tsunami
___ upwelling
___ wave height
___ wavelength
___ wind

Part 2 Ocean Topography
___ abyssal plain
___ continental rise
___ continental shelf
___ continental slope
___ guyot
___ mid-ocean ridge
___ rift valley
___ seamount
___ trench

Part 3 Ocean Resources and Human Activity
___ over-fishing
___ pollution
___ resources

Unit 10: Meteorology

Part 1 Composition/ Structure of Earth's Atmosphere
___ Earth
___ exosphere
___ ionosphere
___ jet
___ Mars
___ Mercury
___ mesopause
___ mesosphere
___ moon
___ nitrogen
___ oxygen
___ ozone
___ satellite
___ stratopause
___ stratosphere
___ thermosphere
___ tropopause
___ troposphere
___ Venus
___ water vapor

Part 2 Atmosphereic Mechanisms
___ absorption
___ conduction
___ convection
___ radiation
___ reflection

Part 3 Air Masses and Fronts
___ cA
___ cold front
___ cP
___ cT
___ mP
___ mT
___ occluded front
___ stationary front
___ warm front

Part 4 Weather Patterns
___ climate
___ dew point
___ freezing rain
___ hail
___ leeward
___ mountain
___ relative humidity
___ saturated
___ season
___ sleet
___ snow
___ warm
___ water
___ weather
___ windward

Part 5 Miscellaneous Weather Information
___ air pressure
___ atmosphere
___ cirrus

___ cloud
___ Coriolis Effect
___ cumulous
___ doldrums
___ easterlies
___ jet stream
___ land breeze
___ millibar
___ pressure
___ sea breeze
___ station model
___ stratus
___ trade
___ westerlies

Part 6 Severe Weather Occurrences
___ Beaufort Scale
___ Enhanced Fujita Scale
___ hurricane
___ Saffir-Simpson Scale
___ thunderstorms
___ tornado

Part 7 Instruments and Forecasting
___ anemometer
___ barometer
___ isobar
___ isotherm
___ psychrometer
___ rain gauge
___ station model
___ thermometer
___ weather vane

Part 8 Effects of Human and Geologic Activity
___ greenhouse effect
___ ozone

Unit 11: Astronomy

Part 1 The Solar System
___ asteroid
___ asteroid belt
___ astronomical unit
___ comet
___ gaseous
___ Kuiper Belt
___ light year
___ meteor
___ meteorite
___ meteoroid
___ Oort Cloud
___ planet
___ Solar Nebula Theory
___ solar system
___ terrestrial

Part 2 Sun-Earth-Moon System
___ axis
___ crescent
___ full
___ gibbous
___ lunar
___ neap
___ new
___ phases
___ quarter
___ revolution
___ rotation
___ season
___ solar
___ spring
___ tidal range
___ tide
___ tilt
___ waning
___ waxing

Part 3 Sun
___ chromosphere
___ convection
___ core
___ corona
___ flare
___ photosphere
___ prominence
___ solar wind
___ sunspot

Part 4 Stars
___ black
___ black hole
___ constellation
___ fusion
___ H-R Diagram
___ life cycle of stars
___ main-sequence
___ nebula
___ neutron
___ nova
___ protostar
___ red giant
___ supergiant
___ supernova
___ white dwarf

Part 5 Galaxies
___ arms
___ barred spiral
___ black hole
___ central core
___ elliptical
___ Hubble Tuning Fork
___ irregular
___ Milky Way
___ nucleus
___ spiral

Part 6 History and Contributions of the Space Program
___ Apollo 11
___ Edwin (Buzz) Aldrin
___ Neil Armstrong

Part 7 Origin and Evolution of the Universe
___ Big Bang Theory
___ redshift

Test Words and Strategies

The following words may appear in a test question or in the narrative that precedes the question. When you see them, use the highlighter tool or the tool to draw a line and ***mark them***. These words can completely change the format of a question.

advantage	clearly	indicates	most	none	true
always	closest to	least	more likely	not	without
best	disadvantage	less	most likely	primarily	
best fit	except	main	never	rarely	
best represents	false	mainly	next	recently	
better	firmly	more specific	no	significantly	

Also be on the lookout for prefixes such as: un-, non-, in-, im-, mis-, dis-

When taking the test, if there is a diagram, picture, chart or graph study that **first**. Then read the question completely. After reading the question, look back to the diagram, etc. and try to determine the answer **before** even looking at the answer choices. Then look for your answer. If there is any doubt in your mind about the answer you chose, compare every single answer back to the question to see if it clearly answers the question. Use your eliminator tool to strike out answer choices you know are wrong. If you are still in doubt, mark the question for review and come back to it later. Perhaps you will be reminded of the answer while dealing with other questions.

SOL Verbs

Study this list of frequently used SOL verbs. Define them briefly. Learn to say them and understand what they mean. Learn how they are used in an Earth Science context.

SOL Verb	short definition
analyze	
categorize	
clarify	
classify	
communicate	
compact	
compare	
contrast	
correspond	
demonstrate	
derive	
describe	
differentiate	
discover	
discuss	
drive	
estimate	
evaluate	
exert	
exhibit	
explain	

SOL Verb	short definition
generalize	
hypothesize	
infer	
illuminate	
interpret	
investigate	
lessen	
lie	
obtain	
persuade	
portray	
predict	
problem solving	
reasoning	
restate	
show	
simulate	
solve	
speak	
survey	
transform	
verify	
write	

SOL Vocabulary Terms

There are terms that show up over and over again on the Earth Science SOL. Understanding these terms will help you understand what is being asked in the question. Below is a list of the top 25 most often used and misunderstood terms in the Released Earth Science SOLs. Using a dictionary, look up the terms and write out the definition. The word as it appears on the list may not be in the exact form you will find it in the dictionary. Try to determine the root of the word to help you locate its meaning. Also, where there is more than one definition for a word, you need to correctly determine which one is appropriate to our content area. For instance, the word 'subjected' is not likely to be found in that form. However, 'subject' will be found. But there are several definitions. Obviously, the one that talks about the part of a sentence will not be appropriate for Earth Science. Make sure you clearly understand what each of these terms means before taking the Earth Science SOL.

#	Term	Definition as used in Earth Science
1	abundant	
2	accumulate	
3	ascends	
4	associated	
5	composition	
6	conserved	
7	contracting	
8	derived	
9	descends	
10	expanding	
11	horizontal	

#	Term	Definition as used in Earth Science
12	hypothesis	
13	observation	
14	originates	
15	overturned	
16	periodically	
17	primarily	
18	relationship	
19	relative	
20	stationary	
21	subjected	
22	transform	
23	underlain	
24	vertical	
25	vicinity	

Notes and Questions

Use this section to list questions you have that you need clarification on.

Top 10

Suggested Strategies to Use During the SOL

These general test-taking strategies can help you do your best during the SOL.

1 **Focus on the test.**  Try to block out whatever is going on around you. Take your time and think about what you are asked to do. Listen carefully to all the directions.

2 **Budget your time.**  Be sure that you allocate an appropriate amount of time to work on each question on the test.

3 **Take a quick break if you begin to feel tired.** To do this, put your pencil down, relax in your chair, and take a few deep breaths. Then, sit up straight, pick up your pencil, and begin to concentrate on the test again.

4 **Use positive self-talk.** If you find yourself saying negative things to yourself like, "I can't pass this test," it is important to recognize that you are doing this. Stop and think positive thoughts like, "I prepared for this test, and I am going to do my best." Letting the negative thoughts take over can affect how you take the test and your test score.

5 **Mark in your scratch paper.**  Mark key ideas or things you want to come back to in your scratch paper. Use your scratch paper and do a 'brain dump' if necessary.

6 **Read the entire question and the possible answer choices.** It is important to read the entire question so you know what it is asking. Read each possible answer choice. Do not mark the first one that "looks good."

7 **Use what you know.**  Draw on what you have learned in class, from your study guide, and during your study sessions to help you answer the questions.

8 **Use the online tools to help you answer the questions.** Use the highlighter tool to emphasize key words or words that will restrict your choices (like not, except, always, only). There is a line tool that you can use to underline words or key phrases.

9 **Think logically.** If you have tried your best to answer a question but you just aren't sure, use the process of elimination. Look at each possible answer choice. If it doesn't seem like a logical response, eliminate it. Do this until you've narrowed down your choices.

10 **Check your answers.** ☑ When you have finished the test, go back and check your work.

A WORD ON TEST ANXIETY

It is normal to have some stress when preparing for and taking a test. It is what helps motivate us to study and try our best. Some students, however, experience anxiety that goes beyond normal test "jitters." If you feel you are suffering from test anxiety that is keeping you from performing at your best, please speak to your school counselor who can direct you to resources to help you address this problem.

Written and assembled by D. L. Edwards with input from other valued teachers throughout Virginia. Strasburg High School, Strasburg, VA, May/June, 2008; Revised May 2010