G\_\_\_\_\_ time

 Earth’s age of \_\_\_\_\_ years.

 The geologic time line is divided into E\_\_, E\_\_, P\_\_ and E\_\_.

 We currently live in the \_\_\_\_\_ Era, Quaternary Period, \_\_\_\_\_ Epoch.

Geologic \_\_\_\_\_ S\_\_\_ outlines the development of Earth and of life on earth.

 By studying fossils and applying the principle that \_\_\_\_\_ rock layers lie \_\_\_\_\_ younger rock layers, scientists determined \_\_\_\_\_ ages in \_\_\_\_\_ rock.

 Scientists use \_\_\_\_\_ dating and geologic (rock) \_\_\_\_\_ to determine relative age.

Geologic C\_\_\_\_\_

 The theoretical classification system for the layers of rocks and fossils that make up the

Earth's crust with the \_\_\_\_\_ rock layers at the \_\_\_\_\_ of the column.

 Geologists have associated layers of rocks with \_\_\_\_\_ of events thought to have occurred over hundreds of millions of years.

Problems with Geologic Columns

 F\_\_\_\_\_ do not always line up in layers.

 One would expect to find a lesser \_\_\_\_\_ of the fossil record going down the column.

 This is due to the fact that \_\_\_\_\_ rocks would be more likely to have been \_\_\_\_\_ then younger ones.

 U\_\_\_\_\_ exist in the expected rock layers.

R\_\_\_\_\_ Dating  is using rock \_\_\_\_\_ and their positions to tell how \_\_\_\_\_ something is relative to something else. Relative dating uses:

– I\_\_\_\_\_ Fossils

o Fossils that only occur in a \_\_\_\_\_ time period

o These fossils must have a \_\_\_\_\_ time period of existence, be \_\_\_\_\_, and

occur over a \_\_\_\_\_ area.

– M\_\_\_\_\_ B\_\_

o A rock unit with distinctive stratigraphic (rock layer) features which can be traced over a \_\_\_\_\_ area.

o A bed of rock layers that are readily distinguishable by reason of \_\_\_\_\_ characteristics and are traceable over large \_\_\_\_\_ distances.

o Examples include \_\_\_\_\_ beds and beds of \_\_\_\_\_ ash after a volcanic eruption.

– Principle of Fossil \_\_\_\_\_

o Rocks that have the \_\_\_\_\_ fossils were deposited at the same \_\_\_\_\_.

o Fossil organisms originate, coexist, and disappear from the geologic record in a

definite \_\_\_\_\_ order.

Relative Dating Laws:

• S\_\_\_\_\_  The \_\_\_\_\_ rock layers are on the \_\_\_\_\_, \_\_\_\_\_ on the top.

• Original H\_\_\_\_\_  Layers of \_\_\_\_\_ are deposited horizontally.

• C\_\_\_\_\_ Relationships  Any fault, or intrusion is \_\_\_\_\_ than the material it cuts through.

Identify the layers/events from oldest to youngest:

Layer F is \_\_\_\_\_ away

F\_\_\_\_\_ H caused the rock layers to shift.

A\_\_\_\_\_ Dating

 Uses methods such as radiometric dating or rates of geologic processes to determine a \_\_\_\_\_ age of a rock.

 Radiometric dating uses the known \_\_\_\_\_ values of radiometric isotopes found in certain rocks to determine the \_\_\_\_\_ of those rocks.

R\_\_\_\_\_ dating:

 A technique used to \_\_\_\_\_ materials such as rocks.

 Usually based on a comparison between the observed \_\_\_\_\_ of a naturally occurring r\_\_\_\_\_ \_\_\_\_\_ and its \_\_\_\_\_ products, using known decay rates.

 Among the best-known techniques are radio\_\_\_\_\_ dating, potassium-argon dating, and \_\_\_\_\_-lead dating.

 Radiometric dating is based on the \_\_\_\_\_ of specific atomic \_\_\_\_\_.

 The moment in time at which a particular nucleus decays is unpredictable.

 However, a collection of atoms of a radioactive nuclide decays \_\_\_\_\_ at a rate described by \_\_\_\_\_.

 Half-life is usually given in units of \_\_\_\_\_.

H\_\_\_-L\_\_\_

 Measures the rate of decay of a radioactive \_\_\_\_\_.

 The time it takes for \_\_\_ of an original quantity of a radioactive element to \_\_\_\_\_ into another \_\_\_\_\_.

 Radium-226 has a ½ life of 1,620 years

o This means ½ of a sample of radium will change into other elements after 1,620 years.

o After another 1,620 years, ½ the remaining radium will decay (leaving half the original amount)

 The shorter the half-life of an element, the faster it decays; the more radioactivity it gives off

 Different methods of \_\_\_\_\_ dating vary in the \_\_\_\_\_ over which they are \_\_\_\_\_ and the materials to which they can be applied.

 Isotopes with \_\_\_\_\_ half-lives are useful for dating \_\_\_\_\_ rock.

The global climate is affected by five major factors:

1. E\_\_\_\_ factors

* E\_\_\_\_\_\_ to S\_\_\_ Orientation 🡪 Changes in the shape of Earth’s \_\_\_\_ & the \_\_\_\_ and position of Earth’s axis can affect the amount of sunlight reaching Earth’s surface.

The tilt of Earth's axis results in the \_\_\_\_.

* S\_\_\_\_\_\_ O\_\_\_\_ 🡪 The intensity of the sunlight can cause either \_\_\_\_ (during periods of stronger solar intensity) or \_\_\_\_ (during periods of weaker solar intensity).

2. A\_\_\_\_ factors

* + Atmospheric A\_\_\_\_ (reflectivity) 🡪 When sunlight reaches Earth, the amount that is \_\_\_\_ or absorbed depends on Earth’s surface and atmosphere. Reflectivity is affected by a\_\_\_\_. Aerosols are small particles or liquid droplets in the atmosphere that can absorb or reflect \_\_\_\_.
		- * C\_\_\_\_ of the Atmosphere 🡪 An important aspect of global air circulation is the movement of \_\_\_\_ through the atmosphere. E\_\_\_\_ from the surface, condensing to form \_\_\_\_ blown by the winds, returning to the Earth as \_\_\_\_.
			* Aerosols absorb or reflect sunlight 🡪 black \_\_\_\_ \_ (soot from burning), have a \_\_\_\_ effect; \_\_\_\_ emissions from burning coal have a \_\_\_\_ effect

3. L\_\_\_\_ and O\_\_\_\_ factors

* + S\_\_\_\_ Albedo (reflectivity) 🡪 Light-colored objects and surfaces, like \_\_\_\_ and clouds, tend to \_\_\_\_ most sunlight, while darker objects and surfaces, like the \_\_\_\_, forests, or \_\_\_\_, tend to \_\_\_\_ more sunlight.
	+ Surface/Atmosphere \_\_\_\_ 🡪 \_\_\_\_ vapor is constantly cycling through the atmosphere. Water has a much higher \_\_\_\_\_ capacity than the atmospheric gases and rocks.
	+ The bulk of the \_\_\_\_ energy at the Earth surface is stored in the \_\_\_\_ and a key factor in \_\_\_\_ Earth's climate.

4. T\_\_\_\_ factors

* C\_\_\_\_ Drift 🡪 The formation of separate continental land masses \_\_\_\_ the flow of ocean currents and winds. Important factors include: \_\_\_\_ features of the lithosphere; \_\_\_\_ of the land masses; \_\_\_\_ and water bodies
* V\_\_\_\_ Emissions 🡪 Volcanic particles that reach the upper atmosphere can \_\_\_\_ enough sunlight back to space to \_\_\_\_ the surface of the planet by a few tenths of a degree for several years.

Atmospheric Composition & Climate

* Earth is the only planet in our solar system that can sustain \_\_\_\_\_.
* Earth has a blanket of gases that contains the air that we breathe and \_\_\_\_ us from the blasts of heat and radiation emanating from the sun. C\_\_\_\_\_\_ D\_\_\_\_ is the most significant gas that influences \_\_\_\_.

Climate & \_\_\_\_\_

* Because the earth is \_\_\_\_\_ heated, the energy from the equator is continually being transported towards the poles. As a result of this process (and our rotating planet), global circulation patterns of \_\_\_\_ and ocean \_\_\_\_ have developed.

The C\_\_\_\_ Effect 🡪

* The circulation of the atmosphere and oceans is affected by the earth’s \_\_\_\_.
* Free moving objects appear to \_\_\_\_ to the \_\_\_\_ of their intended path in the \_\_\_\_ hemisphere and curve to the \_\_\_\_ in the southern hemisphere.

Winds produce ocean water **\_\_\_\_** currents. \_\_\_\_ differences produce ocean water **\_\_\_\_** currents. Cooler, \_\_\_\_ water at higher latitudes \_\_\_\_ down when the wind brings warmer water from lower latitudes.

Thermoh\_\_\_\_ Circulation and Climate

* Ocean currents are the result of differences in density (created by differences in temperature and salinity (\_\_\_\_ content – “haline”))
* These ocean \_\_\_\_ produce extensive \_\_\_\_ between the ocean basins, making the Earth's oceans a global system.
* Water masses transport both \_\_\_\_ (in the form of heat) and \_\_\_\_ (solids, dissolved substances, and gases around the globe)
* This circulation creates patterns of \_\_\_\_ movement affecting global and regional climate.
* Warm water / air move from the equator towards the \_\_\_\_, and vice versa

El N\_\_\_\_\_\_

* The \_\_\_\_ of climate pattern's oscillations cause extreme weather (such as \_\_\_\_, typhoons, cyclones, and \_\_\_\_) in many regions of the world.
* El Nino is a result of the reversing (or weakening) of the Southern O\_\_\_\_– A regular flow of ocean water from the East Pacific Ocean to the West Pacific Ocean.
* During an El Nino, the Southern Oscillation is diminished.
* T\_\_\_\_ winds weaken and the pressure decreases off the Pacific coast of S. America;
* This offsets the paths of the \_\_\_\_\_ streams that affect \_\_\_\_ in North America.

The oceans dissolve gases in the atmosphere, and help to regulate the \_\_\_\_ of our planet by doing this. The \_\_\_\_ are a major absorber of \_\_\_\_, and they also release CO2.

Regions of our planet have distinct climates due to these factors: l\_\_\_\_, elevation, ocean c\_\_\_\_ \_\_\_\_, a\_\_\_\_, position relative to large bodies of water.

Maritime climates are \_\_\_\_ compared to continental.

G\_\_\_\_ Effect

* The atmosphere (and the gases in the atmosphere) work like the glass of a green house.
* Greenhouse gases in the atmosphere work to \_\_\_\_ heat.
* Our atmosphere allows the \_\_\_\_ wavelength U\_\_\_\_- Radiation from the sun in, but the \_\_\_\_ \_\_\_ I\_\_\_ Radiation that the earth re-radiates, is trapped by the Green House Gases (GHGs).
* Four main GHG’s are (in order of significance):
	+ W\_\_\_\_ Vapor (H2O)
	+ C\_\_\_\_ Dioxide (CO2)
	+ M\_\_\_\_ (CH4)
	+ N\_\_\_\_ O\_\_\_\_ (N2O)
* The earth’s lower atmosphere is composed mainly of \_\_\_\_\_ and \_\_\_\_\_ (gases).

Global Warming

* Over the past 150 years, global temperature have increased by nearly 1⁰ C.



Political Environment: Human Activity Affects Climate

* In particular, burning \_\_\_\_\_ fuels produces gases that increase the \_\_\_\_\_ effect.
* It is believed that these additional gases have a direct and significant impact on \_\_\_\_\_.
* \_\_\_\_\_ removes trees that absorb CO2.
* \_\_\_\_\_ \_\_\_\_\_ melt adding freshwater to the oceans (salt water). Because of the density differences, convection \_\_\_\_\_ are created. Water is transported in a way that did not occur previously, \_\_\_\_\_ weather patterns.

O\_\_\_\_ (O3) is in the upper atmosphere

* Ozone works to filter \_\_\_\_\_ radiation, so that not all of the UV radiation is reaching the surface.
* Some gases work to destroy Ozone, such as \_\_\_\_ ’s (Chlorofluorocarbons); specifically, the Chlorine in CFC’s
* Ozone that is in the stratosphere is \_\_\_\_\_ – it helps filter damaging Ultraviolet radiation.
* Ozone that is at the \_\_\_\_ level is damaging to breath in (burns the lungs). Ground level ozone is created when Nitrogen Oxide combines with Volatile organic compounds and \_\_\_\_\_\_ weather with direct sun.
* Very \_\_\_\_ temperatures will make it easier for Chlorine to \_\_\_\_ ozone. These conditions exist at the \_\_\_\_, but more so at the South Pole.
	+ The South Pole has \_\_\_\_ temperatures because a \_\_\_\_ mass (continent of Antarctica) exists there and land has a \_\_\_\_ specific heat (this means it can get much \_\_\_\_ than an area covered in water)
	+ For this reason, a “\_\_\_\_”, or more correctly described as a lower \_\_\_\_, in the ozone develops to significant size near the end of the Antarctic Winter.

Good Ozone / Bad Ozone

* Ozone that is in the \_\_\_\_ is \_\_\_\_ – it helps filter damaging \_\_\_\_ radiation.
* Ozone that is at the \_\_\_\_ level is \_\_\_\_ to breath in (burns the \_\_\_\_).
* Ground level ozone is created when Nitrogen Oxide combines with Volatile organic compounds and hot weather with direct sun.

Positives of Ozone

* *It is a common misconception in political circles that greenhouse gases like CO2 are breaking down the* \_\_\_\_ *layer, making the earth warmer.*
* *The ozone layer in the stratosphere filters the harmful ultra violet portion of the solar radiation*
* *Otherwise, the earth would be* \_\_\_\_ *and we will be affected by skin cancer.*
* *Some vegetation which are sensitive to ultra violet radiation may not survive at all.*

The advantages of CFCs:

* Excellent \_\_\_\_: *low boiling point, unreactive*
* Very good propellants: *low toxicity, no fire risk*
* Very \_\_\_\_ compared to other compounds for similar uses.
* Very useful in \_\_\_\_: *no fire risk, easy to store and use*
* Useful in precursors for Teflon and other related compound production.
* Useful in drycleaning: *low* \_\_\_\_ *to humans*

The primary greenhouse gases in Earth’s atmosphere are water vapor, CO2, methane, nitrous oxide and \_\_\_\_.

* What’s wrong with this picture?
	+ Politicians have changed laws (remove CFC’s) in order to decrease the ozone depletion.
	+ If there is less ozone (GHG) … shouldn’t the earth’s temperature cool down?

ANSWERS

Geologic time

 Earth’s age of 4.6 billion years.

 The geologic time line is divided into Eons, Eras, Periods and Epochs.

 We currently live in the Cenozoic Era, Quaternary Period, Holocene Epoch.

Geologic Time Scale outlines the development of Earth and of life on earth.

 By studying fossils and applying the principle that older rock layers lie below younger rock layers, scientists determined relative ages in sedimentary rock.

 Scientists use radiometric dating and geologic (rock) columns to determine relative age.

Geologic Columns

 The theoretical classification system for the layers of rocks and fossils that make up the

Earth's crust with the oldest rock layers at the bottom of the column.

 Geologists have associated layers of rocks with sequence of events thought to have occurred over hundreds of millions of years.

Problems with Geologic Columns

 Fossils do not always line up in layers.

 One would expect to find a lesser quality of the fossil record going down the column.

 This is due to the fact that older rocks would be more likely to have been distorted then younger ones.

 Unconformities exist in the expected rock layers.

Relative Dating is using rock layers and their positions to tell how old something is relative to something else. Relative dating uses:

– Index Fossils

o Fossils that only occur in a specific time period

o These fossils must have a short time period of existence, be distinguishable, and

occur over a large area.

– Marker Beds

o A rock unit with distinctive stratigraphic (rock layer) features which can be traced over a wide area.

o A bed of rock layers that are readily distinguishable by reason of physical characteristics and are traceable over large horizontal distances.

o Examples include coal beds and beds of volcanic ash after a volcanic eruption.

– Principle of Fossil Succession

o Rocks that have the same fossils were deposited at the same time.

o Fossil organisms originate, coexist, and disappear from the geologic record in a

definite sequential order.

Relative Dating Laws:

• Superposition  The oldest rock layers are on the bottom, youngest on the top.

• Original Horizontality  Layers of sediment are deposited horizontally.

• Crosscutting Relationships  Any fault, or intrusion is younger than the material it cuts through.

Identify the layers/events from oldest to youngest:

**E-I-A-G-M-D-N-K-E**

Layer F is eroding away

Fault H caused the rock layers to shift

Absolute Dating

 Uses methods such as radiometric dating or rates of geologic processes to determine a specific age of a rock.

 Radiometric dating uses the known half-life values of radiometric isotopes found in certain rocks to determine the age of those rocks.

Radiometric dating:

 A technique used to date materials such as rocks

 Usually based on a comparison between the observed abundance of a naturally occurring radioactive isotope and its decay products, using known decay rates.

 Among the best-known techniques are radiocarbon dating, potassium-argon dating, and uranium-lead dating.

 Radiometric dating is based on the decay of specific atomic nuclei.

 The moment in time at which a particular nucleus decays is unpredictable

 However, a collection of atoms of a radioactive nuclide decays exponentially at a rate described by half-life

 Half-life is usually given in units of years.

Half-Life

 Measures the rate of decay of a radioactive isotope

 The time it takes for ½ of an original quantity of a radioactive element to decay into another element.

 Radium-226 has a ½ life of 1,620 years

o This means ½ of a sample of radium will change into other elements after 1,620 years

o After another 1,620 years, ½ the remaining radium will decay (leaving ¼ the original amount)

 The shorter the half-life of an element, the faster it decays; the more radioactivity it gives off

 Different methods of radiometric dating vary in the timescale over which they are accurate and the materials to which they can be applied.

 Isotopes with long half-lives are useful for dating older rock.

The global climate is affected by five major factors:

1. Extra-terrestrial factors

* Earth to Sun Orientation 🡪 Changes in the shape of Earth’s orbit as well as the tilt and position of Earth’s axis can affect the amount of sunlight reaching Earth’s surface.

The tilt of Earth's axis results in the seasons.

* Solar Output 🡪 The intensity of the sunlight can cause either warming (during periods of stronger solar intensity) or cooling (during periods of weaker solar intensity).

2. Atmospheric factors

* + Atmospheric Albedo (reflectivity) 🡪 When sunlight reaches Earth, the amount that is reflected or absorbed depends on Earth’s surface and atmosphere. Reflectivity is affected by aerosols. Aerosols are small particles or liquid droplets in the atmosphere that can absorb or reflect sunlight.
		- * Composition of the Atmosphere 🡪 An important aspect of global air circulation is the movement of water through the atmosphere. Evaporating from the surface, condensing to form clouds blown by the winds, returning to the Earth as precipitation.
			* Aerosols absorb or reflect sunlight 🡪 black carbon (soot from burning), have a warming effect; Sulfur emissions from burning coal have a cooling effect

3. Land and Oceanic factors

* + Surface Albedo (reflectivity) 🡪 Light-colored objects and surfaces, like snow and clouds, tend to reflect most sunlight, while darker objects and surfaces, like the ocean, forests, or soil, tend to absorb more sunlight.
	+ Surface/Atmosphere exchange 🡪 Water vapor is constantly cycling through the atmosphere. Water has a much higher heat capacity than the atmospheric gases and rocks.
	+ The bulk of the thermal energy at the Earth surface is stored in the oceans and a key factor in stabilizing Earth's climate.

4. Tectonic factors

* Continental Drift 🡪 The formation of separate continental land masses changed the flow of ocean currents and winds. Important factors include: Physical features of the lithosphere; Position of the land masses; Mountains and water bodies
* Volcanic Emissions 🡪 Volcanic particles that reach the upper atmosphere can reflect enough sunlight back to space to cool the surface of the planet by a few tenths of a degree for several years.

5. Human Activity

Atmospheric Composition & Climate

* Earth has a blanket of gases that contains the air that we breathe and protects us from the blasts of heat and radiation emanating from the sun. Carbon Dioxide is the most significant gas that influences climate.

Ocean & Climate

* Because the earth is unequally heated, the energy from the equator is continually being transported towards the poles. As a result of this process (and our rotating planet), global circulation patterns of wind and ocean currents have developed.

The Coriolis Effect 🡪

* The circulation of the atmosphere and oceans is affected by the earth’s rotation
* Free moving objects appear to curve to the right of their intended path in the northern hemisphere and curve to the left in the southern hemisphere.

Winds produce ocean water **surface** currents. Density differences produce ocean water **deep** currents. Cooler, denser water at higher latitudes sinks down when the wind brings warmer water from lower latitudes.

Thermohaline Circulation and Climate

* Ocean currents are the result of differences in density (created by differences in temperature and salinity (salt content – “haline”))
* These ocean currents produce extensive mixing between the ocean basins, making the Earth's oceans a global system.
* Water masses transport both energy (in the form of heat) and matter (solids, dissolved substances, and gases around the globe)
* This circulation creates patterns of air movement affecting global and regional climate.
* Warm water / air move from the equator towards the poles, and vice versa

El Nino

* The extremes of climate pattern's oscillations cause extreme weather (such as floods, typhoons, cyclones, and droughts) in many regions of the world.
* El Nino is a result of the reversing (or weakening) of the Southern Oscillation – A regular flow of ocean water from the East Pacific Ocean to the West Pacific Ocean.
* During an El Nino, the Southern Oscillation is diminished.
* Trade winds weaken and the pressure decreases off the Pacific coast of S. America;
* This offsets the paths of the jet streams that affect weather in North America.

The oceans work to dissolve gases in the atmosphere, and help to regulate the temperature of our planet by doing this. The oceans are a major absorber of CO2, and they also release CO2.

Regions of our planet have distinct climates due to these factors: latitude, elevation, ocean currents, albedo, position relative to large bodies of water.

Maritime climates are moderate compared to continental.

Green House Effect

* The atmosphere (and the gases in the atmosphere) work like the glass of a green house.
* Greenhouse gases in the atmosphere work to trap heat.
* Green House Gases trap heat in our atmosphere.
* Our atmosphere allows the short wavelength Ultraviolet Radiation from the sun in, but the long Infrared Radiation that the earth re-radiates, is trapped by the Green House Gases (GHGs).
* Four main GHG’s are (in order of significance):
	+ Water Vapor (H2O)
	+ Carbon Dioxide (CO2)
	+ Methane (CH4)
	+ Nitrous Oxide (N2O)



Human Activity Affects Climate

* Burning fossil fuels (among other substances) produces many green house (and other) gases that enter the atmosphere
* It is believed that these additional gases have a direct and significant impact on climate

Ozone (O3) is in the upper atmosphere

* Ozone works to filter UV radiation, so that not all of the UV radiation is reaching the surface.
* Some gases work to destroy Ozone, such as CFC’s (Chlorofluorocarbons); specifically the Chlorine in CFC’s
* Ozone that is in the stratosphere is good – it helps filter damaging Ultraviolet radiation.
* Ozone that is at the ground level is damaging to breath in (burns the lungs). Ground level ozone is created when Nitrogen Oxide combines with Volatile organic compounds and hot weather with direct sun.
* Very cold temperatures will make it easier for Chlorine to destroy ozone. These conditions exist at the poles, but more so at the South Pole.
	+ The South Pole has cooler temperatures because a land mass (continent of Antarctica) exists there and land has a lower specific heat (this means it can get much colder than an area covered in water)
	+ For this reason, a “hole”, or more correctly described as a lower concentration, in the ozone develops to significant size near the end of the Antarctic Winter.

Positives of Ozone

* *It is a common misconception in political circles that greenhouse gases like CO2 are breaking down the ozone layer, making the earth warmer.*
* *The ozone layer in the stratosphere filters the harmful ultra violet portion of the solar radiation*
* *Otherwise the earth would be HOTTER and we will be affected by skin cancer.*
* *Some vegetation which are sensitive to ultra violet radiation may not survive at all.*

The advantages of CFCs:

* Excellent refrigerants: *low boiling point, unreactive*
* Very good propellants: *low toxicity, no fire risk*
* Very inexpensive compared to other compounds for similar uses.
* Very useful in firefighting: *no fire risk, easy to store and use*
* Useful in precursors for Teflon and other related compound production.
* Useful in drycleaning: *low toxicity to humans*
* The primary greenhouse gases in Earth’s atmosphere are water vapor, CO2, methane, nitrous oxide and ozone.
* What’s wrong with this picture?
	+ Politicians have changed laws (remove CFC’s) in order to decrease the ozone depletion.
	+ If there is less ozone (GHG) … shouldn’t the earth’s temperature cool down?