Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Period \_\_\_\_

**NOTE OUTLINE: Chapter 21 Fossils & the Rock Record**

**Objectives:**

* The Geologic Time Scale
1. I understand how Earth’s history is divided into sections of time called the geologic time scale. This means I can:
	1. Explain how major changes mark the boundaries between the sections.
	2. Discuss the general changes in organisms from the appearance of life on Earth to present day.
* Fossils
1. I can describe the characteristics of Index Fossils and explain how Index Fossils are used.
2. Discuss how fossils can be used to interpret Earth’s past physical and environmental history.
* Dating of Rocks
1. I can apply the principles for determining relative age to interpret rock sequences. This means I can:
	1. Determine the oldest and youngest layers using the Law of Superposition.
	2. Determine the relative age of layers and intrusions.
	3. Match rock layers in different areas using Correlation.
2. I can apply the principles for determining absolute age using radioactive decay rates and half-lifes.
3. I can discuss the differences in the radioactive decay of different elements. This means…
	1. I can describe when to use Carbon-14 vs Uranium-238.
	2. I can describe limitations of Carbon-14 and Uranium-238 when dating objects.

**TWO Types of Dating of Rocks**

1. Absolute Dating determines the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ age in \_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Relative Dating simply classifies rocks or fossils as \_\_\_\_\_\_\_\_\_\_\_\_or \_\_\_\_\_\_\_\_\_\_

***ABSOLUTE* - Age Dating of Rocks**

**Review:** Absolute Dating determines the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ age in \_\_\_\_\_\_\_\_\_

**Radioactive decay** of elements is used to determine the absolute age of rocks

1. Radioactive elements \_\_\_\_\_\_\_\_\_\_\_\_\_\_ into a \_\_\_\_\_\_\_\_\_element
	* Example: \_\_\_\_\_\_\_\_\_\_\_\_\_ changes into \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Half-Life**

1. The **half-life** of an element is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the atoms in the element to

decay into a new element.

1. By measuring the percent of parent isotope left, absolute age can be determined.

 ****

**Your Turn: Half-Life Determination from Graph**



What is the half-life in this graph?

**Review of Computer Simulations: What Radioactive Elements can be used for Dating?**

|  |  |  |
| --- | --- | --- |
|  | **Carbon - 14** | **Uranium** |
| **What is it’s half-life?** |  |  |
| **What objects can it date?** |  |  |
| **What are it’s limitations? (When can it NOT be used?)** |  |  |

**Carbon Dating**

1. C-14 is used to date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ remains
2. During life, animal \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in foods
3. After death, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is taken in.
4. Age of a fossil is calculated by how much C-14 is left.
5. Older fossils have:
	* Less C-14
	* More Nitrogen (What C-14 turns into)
6. Can only be used on fossils \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ years old

**Other Radioactive Elements**

1. Other elements used to date rocks include:
	1. Uranium-238 (U-238)
* Half-life = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Years
* Used on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ years old
* Uranium changes to \_\_\_\_\_\_\_\_\_\_\_
	1. Uranium-235 (U-235) Half-life = 0.7 Billion Years
	2. Potassium-40 (K-40) Half-life = 1.25 Billion Years

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Percentage** **Uranium -238** | **Percentage****Lead** | **Age** **(billions of years)** |
| Beginning Amount |  |  |  |
| After one half-life |  |  |  |
| After two half-lives |  |  |  |
| After three half-lives |  |  |  |
| After four half-lives |  |  |  |

***RELATIVE* - Age Dating of Rocks**

**Ways to Determine Relative Age**

1. Law of Superposition can be used in rock that is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (moved around by tectonic forces)
	1. Older rocks on \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
	2. Younger rocks on \_\_\_\_.
2. Uniformitarianism: Theory that states the \_\_\_\_\_\_\_\_\_\_\_\_\_\_happening on Earth \_\_\_\_\_\_\_\_\_ have been

occurring since Earth \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. 2 types of processes:
* \_\_\_\_\_\_\_\_\_\_\_\_\_everyday processes
	+ take thousands of years to change the land
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ events
	+ change the land instantly:
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
1. **Exceptions** to Law of Superposition

1. Earthquakes, faults, volcanism, flooding, weathering & erosion:
	* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_the rock layers
	* Make it \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to use the Law of Superposition
2. **Intrusion**: \_\_\_\_\_\_\_\_\_\_\_\_\_that flows \_\_\_\_\_\_\_\_\_\_\_\_\_ of existing rocks and cools into igneous rock
	* Intrusions are always \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_than the layers they pass through
3. Distinctive Sediment Layers
	1. **Correlation** is matching rock layers from one location to another by matching\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Examples:

* Sandstone containing oil, ammonite fossils
* Grand Canyon (Arizona), Zion (Utah), Bryce (Utah)
	1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ events such as \_\_\_\_\_\_\_\_\_\_\_ impact or massive \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 form DISTINCTIVE layers used to determine relative age.

Examples:

* + - Mount St. Helen’s 1980 – \_\_\_\_\_\_\_over several states makes a layer known to have

 been made in\_\_\_\_\_\_\_\_\_\_\_\_\_

* + - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ impact at the boundary of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_and

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ time periods left a layer of space material.

* + - * Layer is age of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ extinction

**Section 21.1 Geologic Time**





**Measuring Time:**

* According to current theories, the Earth has existed for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ years

**What Units of Time are Used to Measure Earth’s History??**

The 4 Main Units:

1. Eon: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ amount of time
2. Era
3. Period
4. Epoch: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ amount of time

How Are They Listed?

1. Recent at \_\_\_\_\_\_\_\_\_\_\_
2. Oldest listed at \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Precambrian Time**

1. Began with the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_of the Earth (\_\_\_\_\_\_\_\_\_\_\_\_\_\_ years ago)
2. At first, there was \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. The first organisms appeared in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ , \_\_\_\_\_ billion years ago
	* They were single-celled \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Cambrian Explosion – Beginning of Paleozoic Era**

1. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ marks the boundary between Precambrian Time & Paleozoic Era.
	* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ life forms appeared
	* Organisms had \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ parts (shells, exoskeletons) which left many more fossils

**Beginning of Mesozoic Era**

1. Many \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_became \_\_\_\_\_\_\_\_\_ at the boundary between Paleozoic & Mesozoic Eras.
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ appear
3. Mesozoic Era is known as the “Age of \_\_\_\_\_\_\_\_\_\_\_\_\_”

**End of Mesozoic Era**

1. All \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and many animals & plants went \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Theory:
	* Scientists think an \_\_\_\_\_\_\_\_\_\_\_\_\_\_ hit Earth
	* Dust clouds blocked the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, causing \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_to die, then herbivores, then carnivores.

**Cenozoic Era**

1. Current era – the one we are living in
2. AKA: Age of \_\_\_\_\_\_\_\_\_\_\_.
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ appear.
4. We know the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ about this Era because the fossils are in the \_\_\_\_\_\_\_ layers and are easier to find

**Why Do We Switch Eras?**

**Class Discussion:** What are the **Actual Reasons There Are Era Switches**?

YOUR **IDEAS:** Using the information on pages 4-6 of your notes, work with your group and create an **inference** on how time is divided. Record your **thoughts** in this box.

**How Are Smaller Periods & Epochs Divided?**

Smaller divisions of time (Periods & Epochs) are based on changes in life forms **AND** land formation changes. Examples:

* + North America is covered by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_breaks up
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ form
	+ Grand Canyon forms

**Remains of Organisms in Rock Record**

1. Fossil = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_of a once-living plant or animal
2. Fossils help scientists approximate:
	1. When life began
	2. Types of animals and plants
	3. Extinction of species
3. Most organisms \_\_\_\_\_\_\_\_\_\_\_ and don’t become fossils
4. Fossils are more likely to form if:
	1. Quick \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_occurs
		* Protects the fossil from being eaten by predators
		* Prevents it from being \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	2. Organism has \_\_\_\_\_\_\_\_\_\_\_\_\_\_ body parts (bones, teeth, shells)

**Index Fossils**

1. Index Fossils = Fossils used to **\_\_\_\_\_\_\_\_\_\_\_** rock layers or to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of a rock layer.
2. Characteristics needed to be an Index Fossil:
	* Easily\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	* Lived during a \_\_\_\_\_\_\_\_\_\_\_\_\_ time
3. Examples: Trilobites, dinosaurs

**Trace Fossils**

1. Trace Fossils = INDIRECT evidence of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of life.
2. Examples include:
	* Fossilized \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	* Fossilized \_\_\_\_\_\_\_\_\_\_\_\_\_\_ (coprolites) – can help scientists learn about eating habits of ancient animals

**Half-Life Problem #1**

* We start with 40 grams of Ra-226
* Ra-226 has a half-life of 1620 years
* How much is left after 8100 years?

|  |  |  |  |
| --- | --- | --- | --- |
| # of half-lifes | % Ra-226 Remaining | Time (Years) | Amount (grams) Ra-226 Left |
| 0 |  |  |  |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |

**Half-Life Problem #2**

* A sample of Iodine-131 had an original mass of 16g
* How much will remain in 24 days if the half-life is 8 days?

|  |  |  |
| --- | --- | --- |
| # of half-lifes | # Days | Grams of I-131 remaining |
| 0 |  |  |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |