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 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.

**Section 21.1 Geologic Time**

**Measuring Time:**

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

**How is Time Divided?**

1. Major changes in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mark the boundaries between the sections
2. Most \_\_\_\_\_\_\_sections were divided because a major organism \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

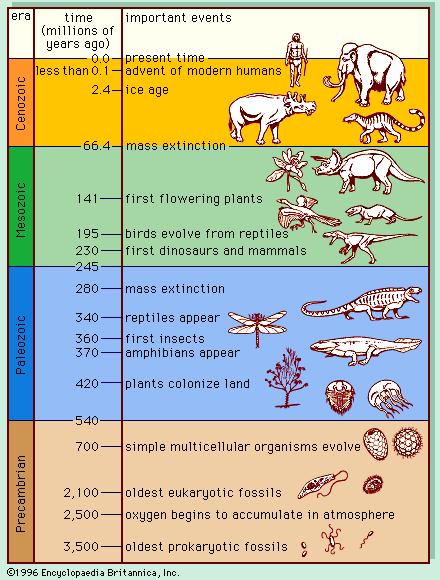
* + Boundary between Paleozoic & Mesozoic Eras: Many \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ &

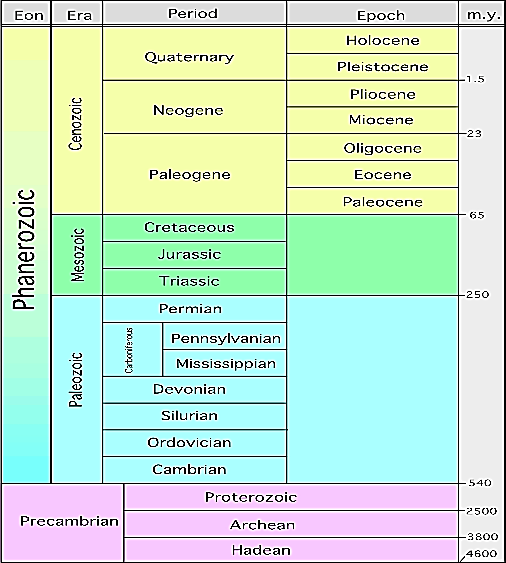
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* + Boundary between Mesozoic Eras & Cenozoic Eras: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ become extinct &

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ become abundant

1. Other divisions based on \_\_\_\_\_\_\_\_\_\_\_\_\_\_formation. Examples:
   * North America is covered by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_breaks up
   * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ form
   * Grand Canyon forms





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

**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\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   * Abundant (\_\_\_\_\_\_\_\_\_\_\_\_\_ numbers) & \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   * Lived during a \_\_\_\_\_\_\_\_\_\_\_\_\_ time to identify a specific time period
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

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

**Two Types of Dating**

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

**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 \_\_\_\_\_\_\_\_\_\_\_\_\_\_and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

left a layer of space material.

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

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Radioactive Skittles



**Data Table:**

|  |  |  |  |
| --- | --- | --- | --- |
| Half-life period | Time passed (million years) | # of radioactive Skittles | # of decayed Skittles |
| 0 | 0 |  |  |
| 1 | 713 |  |  |
| 2 | 1426 |  |  |
| 3 | 2139 |  |  |
| 4 | 2852 |  |  |
| 5 | 3565 |  |  |

**Graphing Data**

\*\*Use the last page of the note packet to make a ***line*** graph showing the number of radioactive Skittles vs. the time passed (million years). Make sure that you include a title for your graph and label both of the axes.

**Analysis Questions**

1. What is the half-life of Skittles (how many years does it take for ½ of the radioactive Skittles to decay)?
2. How many years did it take for the number of radioactive Skittles to reach 25? 12/13?
3. Suppose you had 40 radioactive Skittles. Using your graph determine how many years had passed.
4. After 2,000 million years had passed how many…
   1. Radioactive Skittles would be left?
   2. Skittles would have decayed?
5. Looking at the table of elements used in radioactive dating, identify which element the radioactive Skittles represent. Explain your answer.

|  |  |  |
| --- | --- | --- |
| Elements used in radioactive dating | | |
| Radioactive element | Half-life (years) | Dating range (years) |
| carbon-14 | 5,730 | 500-50,000 |
| potassium-40 | 1.3 billion | 50,000-4.6 billion |
| rubidium-87 | 47 billion | 10 million-4.6 billion |
| thorium-232 | 14.1 billion | 10 million-4.6 billion |
| uranium-235 | 713 million | 10 million-4.6 billion |
| uranium-238 | 4.5 billion | 10 million-4.6 billion |

***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

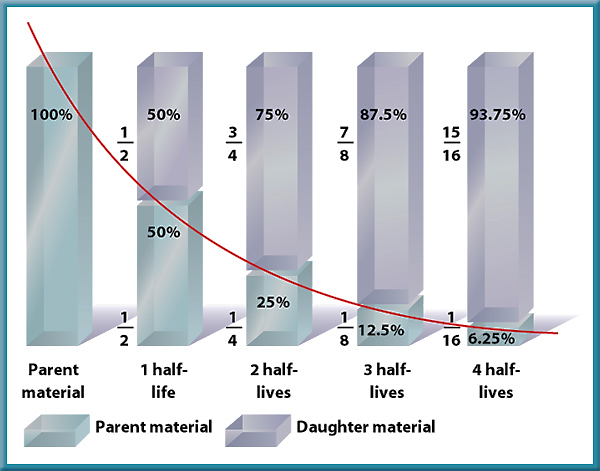
1. Radioactive elements \_\_\_\_\_\_\_\_\_\_\_\_\_\_ into a \_\_\_\_\_\_\_\_\_element
   * Example: \_\_\_\_\_\_\_\_\_\_\_\_\_ changes into \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Original element = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_element
3. New element = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_element
4. Over time there is \_\_\_\_\_\_\_\_\_\_\_parent element and \_\_\_\_\_\_\_\_\_\_\_daughter element
5. During radioactive decay, much \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is given off.
   * \_\_\_\_\_\_\_\_\_\_ from radioactive decay\_\_\_\_\_\_\_\_\_\_\_ the inside of the earth

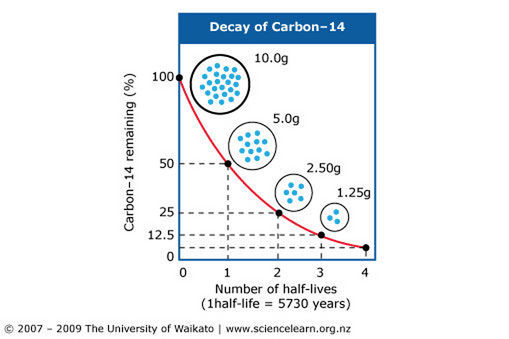
**Half-Life**

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

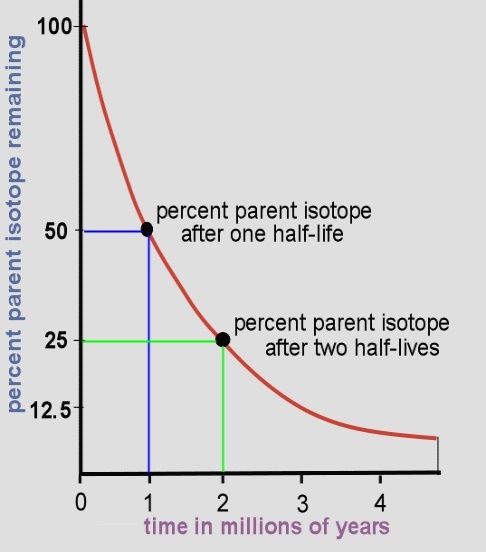
decay into the daughter element.

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



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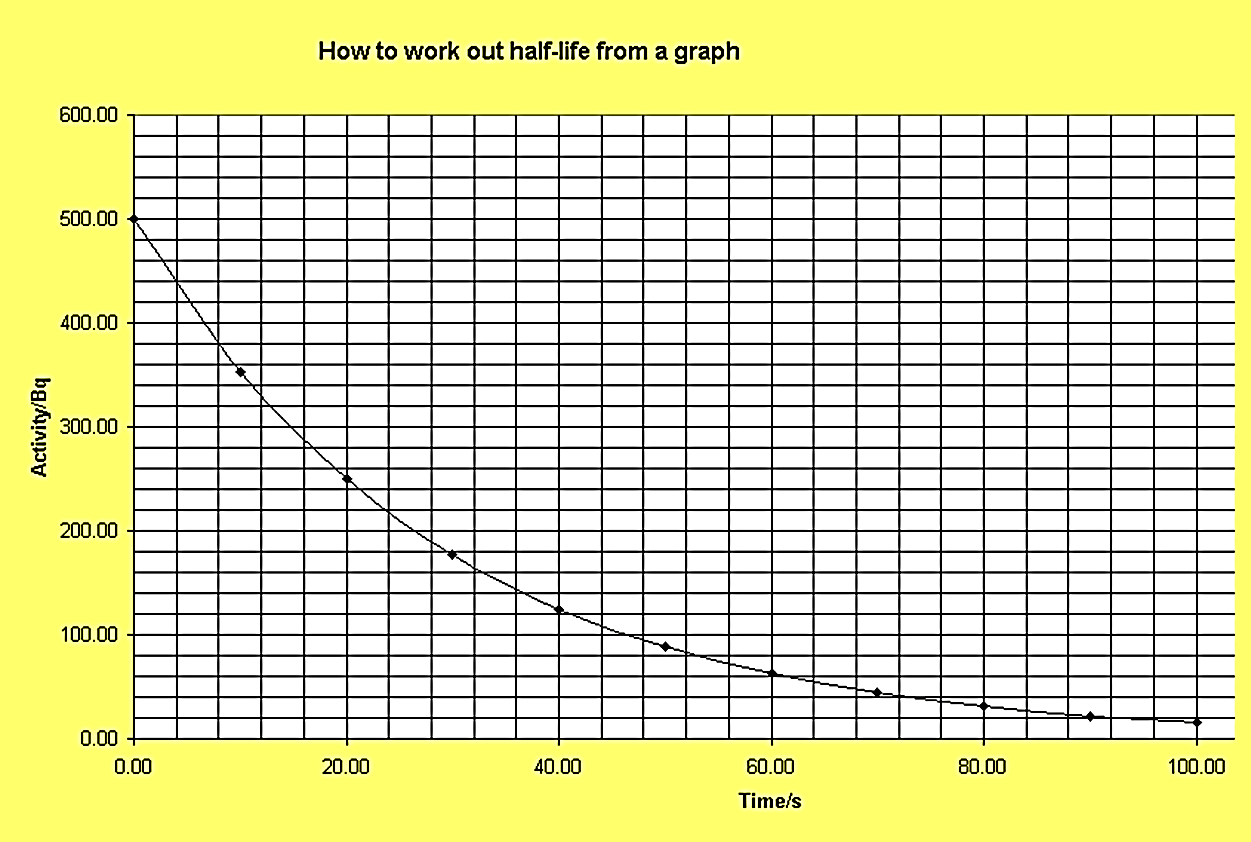
**Example: How Can You Determine Half-Life from a Graph?**



**What is the half life represented in this graph?**

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

What is the half-life in the graph below?



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| S  S  S  Radioactive Skittles | | | | | | | | | | |  |  |  |  |  |  |  |  |  |
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