18. Geologic Time II

The Geologic Column

There are numerous divisions and subdivisions of time in the geologic column. Use the table below to list the hierarchy of major divisions and subdivisions. You should know the difference between different eons, eras, periods, and epochs.

<table>
<thead>
<tr>
<th>Eons</th>
<th>Eras</th>
<th>Periods</th>
<th>Epochs</th>
</tr>
</thead>
<tbody>
<tr>
<td>youngest</td>
<td>C</td>
<td>Q</td>
<td>see below</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>T</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>C</td>
<td>J</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>T</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>P</td>
<td>Pennsylvanian</td>
<td>Mississippian</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>O</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is the collective name for the 3 oldest eons? ___________________________

When did the Cenozoic Era begin? _______________ (after extinction of dinosaurs)

List the 7 epochs from oldest to youngest:

________________, ______________, ______________, ______________,

________________, ______________, ______________,

Modern human beings first appeared during the __________________ Epoch, about ______ million years ago.
The current epoch is called the _______________ Epoch, which began when the last ice age ended ______________ years ago.

**Absolute Age**

Until now we have only considered the relative age of rocks (i.e. stratigraphy). We will now look at how we determine the ACTUAL age of rocks, called the absolute age.

**Estimates of Absolute Age**

Early attempts at estimating absolute ages in the 18th and 19th centuries included measuring how long it must have taken to make the sea salty and how long it must have taken for the Earth to cool from an initially molten state to its current configuration.

What ages for the Earth did scientists calculate using these methods?

- Salinity of the ocean: ______________________
- Time to cool the Earth: ______________________

Ocean salinity was not a good method to gauge the age of the Earth because ocean salinity has oscillated repeatedly over the past _______________ of years.

What was Lord Kelvin unable consider when calculating the cooling time of the Earth? (because it hadn’t been discovered yet!) ______________________

Reliable methods for measuring absolute age MUST involve a natural process that is dependent on time and meets the following criteria:

- it must leave a continuous record without any gaps
- it must be irreversible
- it must not be influenced by chemical reactions or temperature

**Radioactivity**

When was radioactivity discovered? ______________

What is radioactivity? ___________________________________________________
_____________________________________________________________________

Some elements have several **isotopes**. This just means that the atoms have the same number of ____________, but different numbers of _____________. So isotopes represent the same element—they have the same atomic number, but the mass numbers are different.

Most isotopes are stable. But some isotopes are prone to spontaneous change in their nuclei and are said to be unstable. Examples:
The 3 types of radioactive changes that can happen in the atoms of these isotopes are:

1) ______________ - involves the release of an \( \alpha \)-particle
   
   **What is an \( \alpha \)-particle?:** _____________________________
   
   As a result, the atomic number changes by _______ and the mass number changes by __________.

2) ______________ - involves the release of a \( \beta \)-particle as a neutron turns into a proton. What is a \( \beta \)-particle?: ______________________
   
   As a result, the atomic number changes by _______ and the mass number remains unchanged.

3) ______________ - involves a nucleus absorbing an electron, causing a proton to turn into a neutron.
   
   As a result, the atomic number changes by _______.

These processes in isotopes are called **radioactive decay**, and the isotope is said to be radioactive.

An isotope that undergoes radioactive decay is called a ______________ isotope.

The isotope that forms as a result of this process is called a ______________ isotope.

What other two things are emitted from an atom during any type of radioactive decay?

____________________    and    ____________________

We can very precisely measure how rapidly a parent isotope decays into a daughter isotope. This is called the **decay rate**, and it is _________________ through time.

Do all parent isotopes decay into daughter isotopes at the same time?  YES  or  NO

At any point during a decay process, there will always be a bunch of parent isotopes left over, and a bunch of daughter isotopes that formed from parent isotopes that already decayed. Most rocks contain some amount of parent isotopes, and some amount of daughter isotopes. These relative amounts can be measured in the rocks.

The relative amounts of parent and daughter isotopes then tell us how old the rock is.

The reason is that during radioactive decay, the number of parent isotopes is always ________________,

whereas the number of daughter isotopes is always ________________.

By measuring the relative amounts of parent and daughter isotopes, you can calculate how long it took to produce this ratio as long as you know the decay rate.

**Analogy:** if you know how long it takes a dripping tap to fill a glass of water, and how full the glass is at any point in time, you can calculate how long the tap has been dripping water into the glass.
What is meant by the **half-life** of an isotope? __________________________________________________________

___________________________________________

By looking at the ratio of parent to daughter isotopes in a rock, we can figure out __________________________ must have passed to make so many daughter isotopes. This tells us how old the rock is.

Do geologic processes alter the rate of decay? (e.g., is the decay rate different in magma than in sedimentary, or igneous, or metamorphic rocks?) YES or NO

**Calculating the Absolute Ages of Rocks**

Use of radioactive isotopes to determine rock age is called __________________________.

The study of absolute rock ages is called __________________________.

In sedimentary rocks, do the radiometric ages of the grains represent the age of the original rock that got eroded to form sediment, or is it the age of deposition of the sedimentary rock that formed from this sediment? ROCK THAT GOT ERODED or SEDIMENT DEPOSITION AGE

The oldest material found on Earth was a grain of the mineral _____________.

How old is it? __________________________

Where was it found? __________________________

**FINAL QUESTION:**

We consider a good estimate of the age of the Earth to be the age of the moon rocks that have been returned to Earth and dated. How old are they? __________________________

