Scientists use two different methods to estimate the age of geologic events on the Earth. “Relative dating” determines the order in which a series of events occurred (but it can not tell exactly when each event occurred). For most of the history of science, the majority of the rocks in the world could only be given a relative date. In the early 20th century, after the discovery of radioactivity, geologists developed a series of techniques that yield an “absolute”, or numeric, date. Absolute dating yield an exact numeric age for an event, although there is usually some error associated with a measurement. For example a geologist may report the absolute age of 500,000 years plus or minus 5 million years, which means that the rock formed between 495,000 and 505,000 years ago.

**Radiometric dating** (often called radioactive dating) is the most common technique used to produce an absolute date for materials. Radiometric dating is usually based on a comparison between the observed abundance of a naturally occurring radioactive isotope and its decay products, using known decay rates. Radioactive isotopes (parent isotopes) systematically, decay into another element (daughter isotope). The time it takes for half of the parent atoms to decay to form daughter atoms is referred to as the *half-life* of a radioactive isotope. By measuring the proportion of parent isotope to daughter isotope, and knowing the half-life, we are able to determine the absolute age of a rock or fossil fragment. Half-lives of unstable, radioactive isotopes varies from hours to hundreds of millions and even billions of years. Isotopes with long half-lives are best for geologic dating.

Radiometric Dating is the principal source of information about the absolute age of rocks and other geological features, including the age of the Earth itself, and can be used to date a wide range of natural and man-made materials. Among the best-known techniques are:

Radiocarbon dating or Carbon-14 dating. This technique can be used to date materials up to 60,000 years old. The precision of this technique generally ranges from 50 to 2000 years.

and

Uranium-lead dating. Uranium-lead is one of the oldest and most refined radiometric dating schemes. It can be used to date materials containing uranium that have an age range of about 1 million years to over 4.5 billion years. This technique usually has an error 0.1% – 1.0% percent.

Sources / For more information you can go to:

http://en.wikipedia.org/wiki/Radiometric_dating
http://pubs.usgs.gov/gip/geotime/radiometric.html
http://nipissingu.ca/faculty/ingridb/geology/geologic_time.htm
Principles of Relative Dating

Examine the webpage http://nipissingu.ca/faculty/ingridb/geology/geologic_time.htm and define the principles of relative dating listed below

Uniformitarianism:

Original Horizontality:

Superposition:

Cross-cutting relationships:

Principle of Inclusion:

➢ What is “unconformity” and what are the different ways that they can form?
Below are a series of a geologic “cross-sections” that shows a side-view of the structure of a geologic section. Each feature (sedimentary layer, faults, intrusions, etc.) of the diagrams is labeled with a letter. Determine what order the events in each diagram occurred and list them by letter from youngest (most recent) event to oldest event at the side of each diagram.

A - erosion of D & C
B - fault
C - intrusion of igneous rocks
D - deposition of sedimentary rocks
E - deposition of sedimentary rocks
F - erosion of E

Youngest Event

Oldest Event

Sedimentary Layers = A, C, D, E, F, G, H, I, L, & M
Igneous Rocks = B, K
Fault = J
Erosion = N
How many different times were the rocks in this diagram subjected to tilting, and when did this/these event(s) occur. Explain your reasoning.
A = Sedimentary Rock
B = Sedimentary Rock
D = Sedimentary Rock
E = Sedimentary Rock
F = Metamorphic Rock
G = Fault
H = Sedimentary Rock
J = Sedimentary Rock
K = Fault
M = Igneous Rock (plutonic/intrusive)
P = Igneous Rock (plutonic/intrusive)
R = Sedimentary Rock
S = Sediment
X = Volcanic rock

Youngest Event

Oldest Event
Part 2: Absolute/Numerical Dating

Imagine that you have a job in a lab that measures the radioactive decay of isotopes. It is your job to determine the half-life of the compound. You are a busy person! You do not have time to watch the machine all the time, but occasionally you walk by and record the number the amount of the isotope remaining.

The data you collected are graphed below:

<table>
<thead>
<tr>
<th>Minutes</th>
<th>Amount of isotope A (milligrams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>15157</td>
</tr>
<tr>
<td>33</td>
<td>9330</td>
</tr>
<tr>
<td>69</td>
<td>4063</td>
</tr>
<tr>
<td>96</td>
<td>2177</td>
</tr>
<tr>
<td>117</td>
<td>1340</td>
</tr>
<tr>
<td>132</td>
<td>948</td>
</tr>
<tr>
<td>153</td>
<td>583</td>
</tr>
<tr>
<td>192</td>
<td>237</td>
</tr>
<tr>
<td>213</td>
<td>146</td>
</tr>
<tr>
<td>249</td>
<td>63</td>
</tr>
<tr>
<td>297</td>
<td>21</td>
</tr>
<tr>
<td>324</td>
<td>11</td>
</tr>
<tr>
<td>360</td>
<td>5</td>
</tr>
</tbody>
</table>

1. From this graph, at what time was the compound (let’s call it element A) at 10,000 milligrams?

2. From this graph, at what time was the compound at 5,000 milligrams?

3. From this graph, at what time was the compound at 8000 milligrams?

4. From this graph, at what time was the compound at 4000 milligrams?

5. Subtract the time you found for question 1 from the time you found for question 2.

6. Subtract the time you found for question 3 from the time you found for question 4.

7. It may be that the answers to question 5 and question 6 are not the same, but if you have a computer draw the graph, you will find that the answers to questions 5 and 6 are the same time period! This time period is called the half-life of the compound. The half-life is the time period required for half of the atoms to decay. What is the half-life for this compound?

8. What are the units (meters, grams, minutes, etc.) of half-life values? (All half-lives are what units?)

9. How much (in milligrams) was there of this compound at time 0? (Extend your line back to time 0).