Radiometric dating (more details for you)

The half-life is the time is takes for HALF of the remaining RADIOACTIVE parent isotope (N) to decay to the daughter isotope (D):

- **uranium 238 → lead 206** **4470 Ma** (4.47 billion years)
- **uranium 235 → lead 207** **704 million years** (0.704 billion years)
- **rubidium 87 → strontium 86** **47,000 Ma** (47 billion years)
- **potassium 40 → argon 40** **1300 Ma** (1.3 billion years)
- **carbon 14 → nitrogen 14** **5730 years**

Imagine you had a full glass of water. Then you poured out half of the water.

The RATIO of water to air in the glass would be: ½ air over ½ water which is equal to 1.

That's because ½ is the same as ½, so the ratio of the same thing is one!

That's like going through one half-life.

Say you poured out half of the remaining water in the glass.

The new ratio of water to air in the glass would be: ¾ air over ¼ water = 3.

That's like going through a second half-life.

You can make a chart for yourself to see how this is an EXPONENTIAL DECAY in the amount of water remaining in the glass.

Pouring out half of the remaining ¼ glass of water, yields 1/8 of a glass.

So, air over water in the glass is 7/8 divided by 1/8 or 7.

That's like going through a third half-life.

After a while, very little water is left if you keep pouring out half of it!

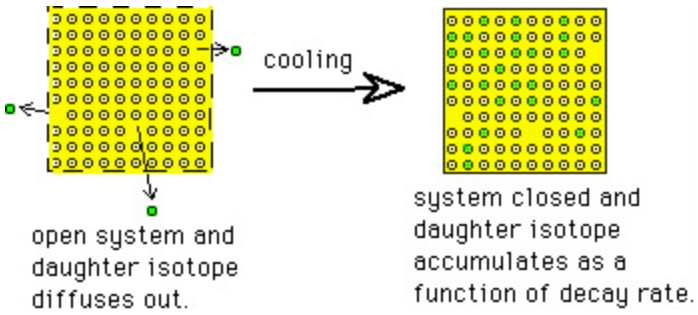
IMPORTANT TO REMEMBER:

Radioactive decay occurs at an exponential rate, meaning that it can be described in terms of a half life. After one half live, half of the original radioactive isotope material in the system under consideration decays. Another half life and half of the remaining material decays, and so on.

A major assumption is that the rock or mineral being dated has been a closed system so that no parent isotope or daughter product has escaped or been added. This assumption can be tested for.

What is being dating? <u>What event sets the clock, or more succinctly, when is the system closed</u>?

- **Significant thermal control.**
- **Age of crystallization.**
- **Time of cooling through closure temperature.**
- **Time since exposed to cosmogenic radiation (time since last exposure)**
    - **Carbon-14 system is a good example of this. Time since death and communication with atmosphere.**
    - **Can also date time since burial or time since exposed using other cosmogenic radiation.**
- **Using different systems on the same rock can get a thermal history.**



Carbon-14 dating:

- **With such a short half-life negligible primordial C-14 left, but it is around, so where does it come from?**
- **Semi-constant production by cosmic ray bombardment so semi-constant C-12 vs. C-14 ratio. From other sources they have worked out history of production and resulting ratio.**
- **When alive an organism is in communication with the atmosphere and maintains this ratio of C-12 to C-14.**
- **When it dies the C-14 decays and the ratio changes so that by measuring the ratio you can calculate time since death.**

What geologic materials can be dated?

- **Depends on what system is being used, which determines what type of event is being dated.**
- **What would the date from a conglomerate mean?**
- **Igneous rocks generally work well, depending on composition. Volcanic rocks, because of their quick and simple cooling history are the best to date.**
- **Whole rock vs. mineral separates.**

Some thoughts on accuracy and error:

- **measurement or analytic error.**
- **contamination (violation of assumptions) error.**

The decay equation: $\text{Age} = 1/\lambda \ln(1+D/N)$