According to http://pubs.usgs.gov/gip/geotime/age.html, the best age for the Earth (4.54 billion years) is based on lead isotope ratios from iron meteorites, specifically the Canyon Diablo meteorite. The assumption is that the meteorites' parent material(asteroids) formed at the same time as the Earth. In addition, for the purposes of verification, mineral grains (zircon) with U-Pb ages of 4.4 billion have been reported from sedimentary rocks in west-central Australia.

But how is this actually calculated?

Let's say that a unstable nucleus, *No*, decays into another nucleus, N:

No→ *N* + energy

With sensitive instruments (mass spectrometers) the relative number of atoms of N and what's left of No can be counted.

N = number of remaining atoms are referred to as daughter atoms, D.
Because of the 1:1 atomic ratio from the equation, *No*, the original number of atoms, is the sum of D and the measured remaining atoms, which we'll call P(for parent).

If we know the half life (the time that it takes for half of the sample to decay) of the original isotope, then

$$\mathrm{D} = (\mathrm{D} + \mathrm{P})\left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$$

where $t_{1/2}$ = half life
t = age of sample.

To make sense of the formula, let's say the half life of an isotope is 5 years. Well after a total time of 10 years, then 10/5 = 2. So after 10 years, we'll have ½ of ½ of the sample remaining, in other words, $(½)^2$ * the original amount.

Now it would be convenient to isolate t, so we just apply a little algebra:

$$\frac{\mathrm{D}}{(\mathrm{D} + \mathrm{P})} = \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$$

Now take the natural logarithm(ln) of each side:

$$\ln\left(\frac{\mathrm{D}}{(\mathrm{D}+\mathrm{P})}\right) = \ln\left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$$

$$\ln\left(\frac{\mathrm{D}}{(\mathrm{D}+\mathrm{P})}\right) = \frac{t}{t_{1/2}}\ln\left(\frac{1}{2}\right)$$

$$t_{1/2}\ln\left(\frac{\mathrm{D}}{(\mathrm{D}+\mathrm{P})}\right) = t\ln(2)^{-1}$$

$$\frac{t_{1/2}\ln\left(\frac{\mathrm{D}}{(\mathrm{D}+\mathrm{P})}\right)}{-\ln(2)} = t$$