

Half-Life & Rock Dating Number Crunches

Example

Potassium-40 (K^{40}) decays to Argon-40 (Ar^{40}) with a half-life of 1.3×10^9 years. A rock is found in Australia that contains 5 grams of K^{40} and 35 grams of Ar^{40} . How old is this rock?

Step 1: How many grams of the parent element were in the rock when it formed? Add the grams of the parent element now to the number of grams of the daughter element now to find the total number of grams of the parent rock at the time that it formed.

Step 2: How many half-lives have gone by since the rock formed? Remember, in each half-life, half of the parent element decays. Count how many times you have to divide your answer from Step 1 in half to until you get the number of grams of the parent element that you have today.

Step 3: How old is the rock? Multiply the number of half-lives elapsed since the rock formed by the length of the half-life for that isotope.

Solve the remaining problems using the methods from the example problem above. Show all of your work on a separate sheet of paper.

1. Radium has a half-life of 25 years. If a Chemistry lab has a sample of 500 grams of Radium and leaves it in storage for 50 years, how much Radium will be there after this time?
2. What is the half-life of X if 80 years ago a sample had 16 grams of X and now the sample has only one gram of X?
3. Organic remains, such as fossilized bones, contains radioactive carbon-14. Carbon-14 (C^{14}) decays to Nitrogen-14 (N^{14}) with a half-life of 5.6×10^3 years. A fossilized bone is found with 2 grams of C^{14} and 62 grams of N^{14} . How old is the bone?
4. Uranium-238 (U^{238}) decays into Lead-206 (Pb^{206}) through a multi-step process that has a half-life of 4.5×10^9 years. If a rock is formed today that has 120 grams of U^{238} , how many grams of U^{238} will there be in 9×10^9 years?
5. In 2014, the first NASA probes to Mars will hopefully return to Earth with samples of rocks that can be analyzed. If a rock sample is returned to Earth that contains 8 grams of K^{40} and 56 grams of Ar^{40} , how old is the rock. (See the Example problem for the half-life of K^{40}).