

Name _____

Course/Section _____

Date _____

Professor/TA _____



Activity 25.2 How do we determine the age of fossils and rocks?

To determine the age of fossils and rocks, scientists determine the amounts of radioactive compounds and their stable daughter products present in the sample. Radioactive elements are known to decay into stable daughter compounds at specific rates. A number of radioactive compounds, their stable daughter compounds, and their half-lives are shown in the table below.

Radioactive compound	Stable daughter compound	Half-life
Carbon 14	Nitrogen 14	5370 years
Potassium 40	Argon 40	1.25 billion years
Rubidium 87	Strontium 87	48.8 billion years
Thorium 232	Lead 208	14 billion years
Uranium 235	Lead 207	704 million years
Uranium 238	Lead 206	4.47 billion years

For dating rocks, the potassium-argon method is often used because:

- Argon is a gas. When rock is molten, any existing argon gas will escape. As a result, newly formed rocks contain no argon.
- As the ^{40}K potassium naturally occurring in the rock decays to ^{40}Ar argon, the ^{40}Ar is trapped in pockets in the rock. The ratio of ^{40}K to ^{40}Ar can be measured to determine the rock's age.

For dating organic material, carbon-nitrogen dating is often used because:

- The ratio of radioactive to nonradioactive carbon dioxide in the atmosphere is fairly constant over time. As a result, the levels of these elements in organic tissue remain relatively constant as long as the organism is alive.
 - Once the organism is dead, no new inputs of carbon occur and the existing radioactive-carbon-to-nonradioactive-carbon ratio will decrease over time as the radioactive carbon decays.
1. In one half-life, half of the original radioactive compound will decay into its stable daughter compound.
 - a. If a newly formed rock contains 100 units of ^{40}K potassium (^{40}K), how many units of potassium 40 (^{40}K) would it contain after 1.25 billion years?
 - b. How many units of argon 40 (^{40}Ar) would the rock contain when newly formed vs. after 1.25 billion years?

- a. What method of dating would be best for this? Describe the general procedure for dating the cloth.
 - b. Assume the cloth is 2,000 years old. How would the level of the radioisotope you used to date it have changed in this period of time?
3. You want to date some fabric that you have discovered at an archeological dig.
 - a. What method of dating would be best for this? Describe the general procedure for dating the cloth.
 - b. Given your answer in a, what would be the ratio of ^{40}K to ^{40}Ar found in the fossil remains?
2. You are fossil hunting and find a trilobite fossil in an old riverbed. You have it radiometrically dated and are told it is 275 million years old.
 - a. In this amount of time, how many half-lives of ^{40}K have elapsed?
 - b. After 1.25 billion years, what would be the ratio of ^{40}K to ^{40}Ar in the rock?
 - c. After 2.5 billion years, what would be the ratio of ^{40}K to ^{40}Ar ?