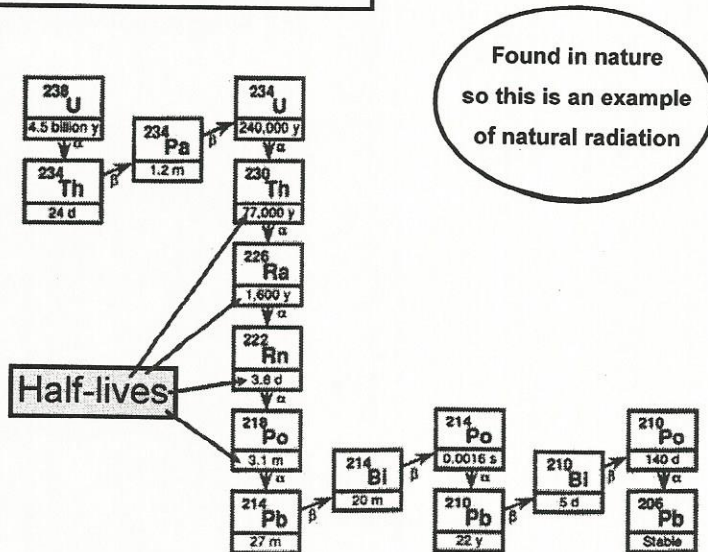


Half-Lives of Radioactive Isotopes

U-238 Decay Chain:



Half-life: for a radioactive isotope, it is the amount of time that it takes for half of the atoms in a sample to decay (e.g. by α - or β -decay) into a different element.

e.g. The half-life of U-238 is 4.5 billion years.

So, if 20g U-238 is present in a sample now, then in 4.5 billion years there will be 10g left (half of the 20g will have decayed, or transmuted, into Th-234).

Half-Life is a constant for each radioactive isotope.

This means that, for U-238 it is ALWAYS 4.5 billion years.

The half-life for Th-234 is ALWAYS 24 days.

The half-life for Pa-234 is ALWAYS 1.2 minutes.

These half-lives don't change, even if the temperature, pressure or surface area is increased!

Some half-life problems:

1 tonne = 1000 kg

1. Uranium-238 has a half-life of 4.5×10^9 years. If 2 tonnes of U-238 are stored away, how much will be left after 13.5×10^9 years?
2. Strontium-90 has a half-life of 28 years. How long will it take for 0.1 mg of Sr-90 to decay to 0.0125 mg?
3. Radiation emitted by the decay of Co-60 is used in treating cancer patients. A 500 g sample of Co-60 is purchased by a hospital. What mass of Co-60 is left after 26.5 years?
The half-life of Co-60 is 5.3 years.
4. a) Iodine-131 is used in medical diagnostic and treatment procedures. The half-life of I-131 is 8 days. How much of a 340 g sample of I-131 will remain after 24 days?

b) Why do you think that radioactive isotopes with short half-lives are used in medical treatments?

5. C-14 undergoes beta decay and its half-life is 5720 years.

a) Write the equation for the beta decay of C-14.

b) Given 250 g of C-14, how many grams of C-14 will remain after 17 190 years?

c) Where did the "lost" C-14 go?

6. a) Ra-226 decays through alpha decay. Write the equation for this transmutation.

b) How long will it take for a 5-tonne sample of Ra-226 to decay until there is only 0.156 tonne left? The half-life of Ra-226 is 1620 years.

c) What has happened to the "missing" Ra-226?

7. a) A half-tonne of U-238 is stored away. How long will it take before only 0.03125 tonne of U-238 remains? (see #1 for half-life)

b) How will this time (found in (a)) be affected if the U-238 is ground up into a powder?

8. a) A 10kg metal pipe contains 804 g of Pb-209. What mass of this isotope will remain after 13.2 hours?

The half-life of Pb-209 is 3.3 hours.

b) If the 10kg metal pipe in (a) is heated to 200 degrees Celcius, then what effect will this have on the rate at which the Pb-209 decays?

9. Ac-228 has a half life of 6 hours. How much of a 5.0 mg sample would remain after one day?

10. A 5kg bone contains 648mg of Sr-90. The half-life of Sr-90 is 29 years. Sr-90 undergoes beta decay.

a) Write the beta decay equation for this transmutation.

b) How long will it be before only 20.25mg of Sr-90 remains.

c) Determine the mass of the product isotope that has been produced during this beta decay.

11. Radon gas is one of the air contaminants near Uranium mines. Rn-222 undergoes alpha decay and its half-life is 3.8 days. What mass of Rn-222 would remain after 19 days?

12. If the Radon gas in question 11 is collected and placed in a very small container to increase its pressure, how will this affect the rate at which the isotope decays?