

## Naturally Occurring or Artificial

Radionuclides	Radiation being emitted	Half-life
Thorium-232 (Th-232)	$\alpha, \gamma$	14.1 billion years
Uranium-238 (U-238)	$\alpha, \gamma$	4.5 billion years
Potassium-40 (K-40)	$\beta, \gamma$	1.3 billion years
Plutonium-239 (Pu-239)	$\alpha, \gamma$	24,000 years
Carbon-14 (C-14)	$\beta$	5,730 years
Cesium-137 (Cs-137)	$\beta, \gamma$	30 years
Strontium-90 (Sr-90)	$\beta$	29 years
Tritium (H-3)	$\beta$	12.3 years
Cesium-134 (Cs-134)	$\beta, \gamma$	2.1 years
Iodine-131 (I-131)	$\beta, \gamma$	8 days
Radon-222 (Rn-222)	$\alpha, \gamma$	3.8 days

Artificial radionuclides are shown in red letters.

$\alpha$ :  $\alpha$  (alpha) particles,  $\beta$ :  $\beta$  (beta) particles,  $\gamma$ :  $\gamma$  (gamma)-rays

Radionuclides with long half-lives, such as Thorium-232 in the thorium series, Uranium-238 in the uranium series, and Potassium-40, were created in the universe in the distant past and taken into the earth when the earth was born.

Thorium-232 and Uranium-238 transform into various radionuclides by emitting  $\alpha$  (alpha)-particles,  $\beta$  (beta)-particles, and  $\gamma$  (gamma)-rays before transforming into Lead-208 and Lead-206, respectively.

Carbon-14, which is also a naturally occurring radionuclide, is created when nitrogen that accounts for 80% of the atmosphere is bombarded with neutron beams, which are cosmic beams. Carbon-14 returns to nitrogen by emitting  $\beta$ -particles.

Cesium-134, Cesium-137, Strontium-90, Iodine-131, and Plutonium-239 can be released into the environment in the event of a nuclear plant accident. Some artificial radionuclides, such as Plutonium-239, have very long half-lives.

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