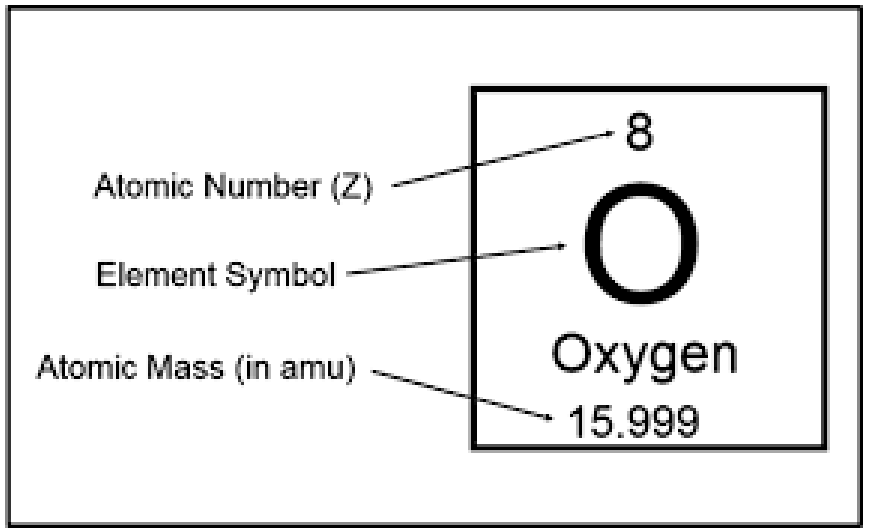


Isotopes

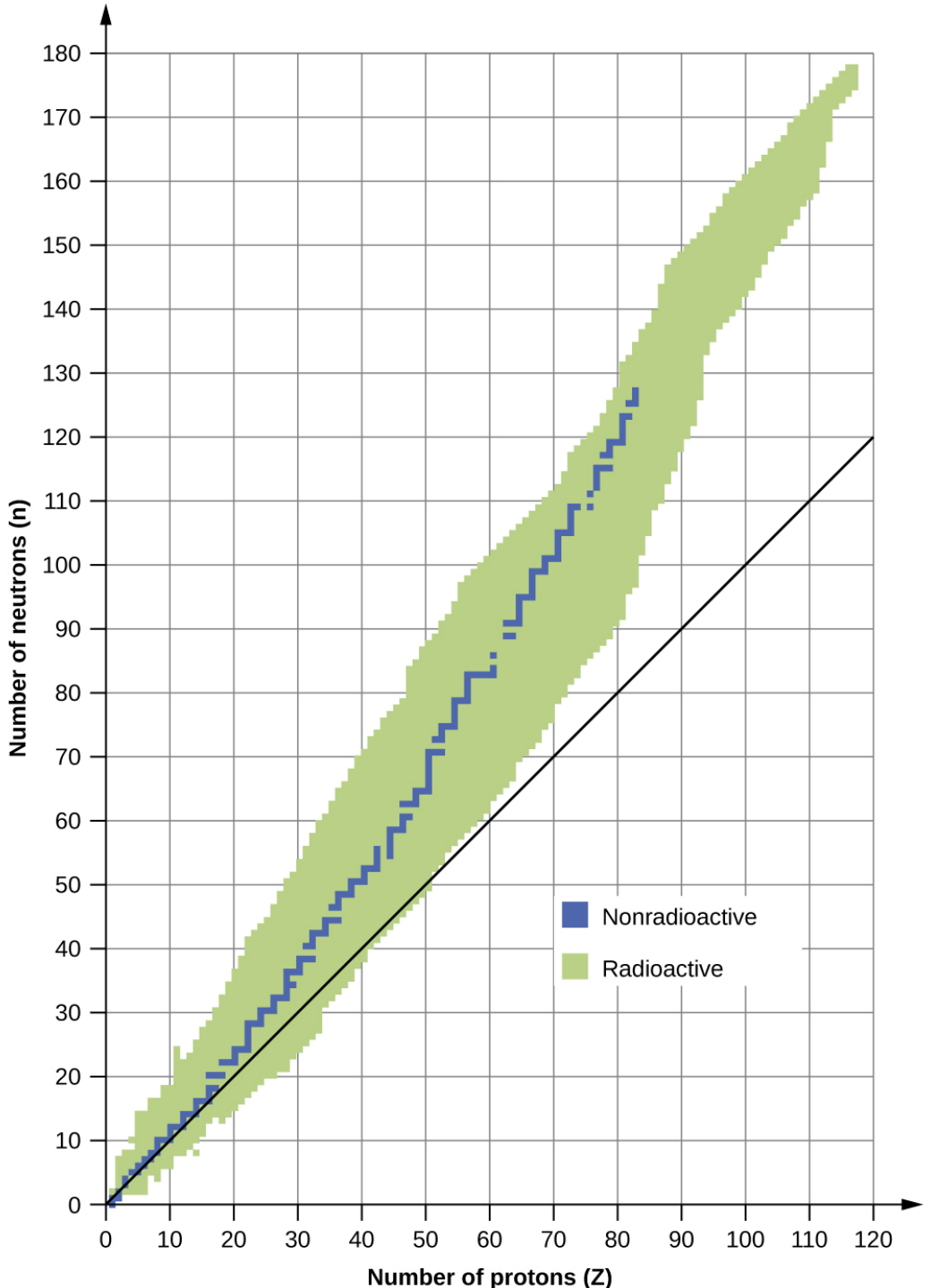
- Same number of protons but different number of neutrons
- Protons + neutrons are called nucleons

Radionuclides

- A nucleus is considered stable if it cannot transform without the addition of outside energy

- A radionuclide in contrast spontaneously decay into other nuclei until they reach a stable isotope

Belt of Stability



Types of Radioactive Decay

Name	Symbol(s)	Representation	Description
Alpha particle	^4_2He or $^4_2\alpha$		(High-energy) helium nuclei consisting of two protons and two neutrons
Beta particle	$^0_{-1}\text{e}$ or $^0_{-1}\beta$		(High-energy) electrons
Positron	$^0_{+1}\text{e}$ or $^0_{+1}\beta$		Particles with the same mass as an electron but with 1 unit of positive charge
Proton	^1_1H or ^1_1p		Nuclei of hydrogen atoms
Neutron	^1_0n		Particles with a mass approximately equal to that of a proton but with no charge
Gamma ray	γ		Very high-energy electromagnetic radiation

https://openstax.org/books/chemistry-2e/pages/21-1-nuclear-structure-and-stability

Writing Nuclear Equations

- Al-27 undergoes alpha decay

- C-14 decays by beta emission

- O-15 undergoes positron emission

- K-40 undergoes electron capture

Radioactive Decay

- Radioisotopes follow first order kinetics!

- $\ln(N_t) = -kt + \ln(N_o)$ and $t_{1/2} = 0.693/k$

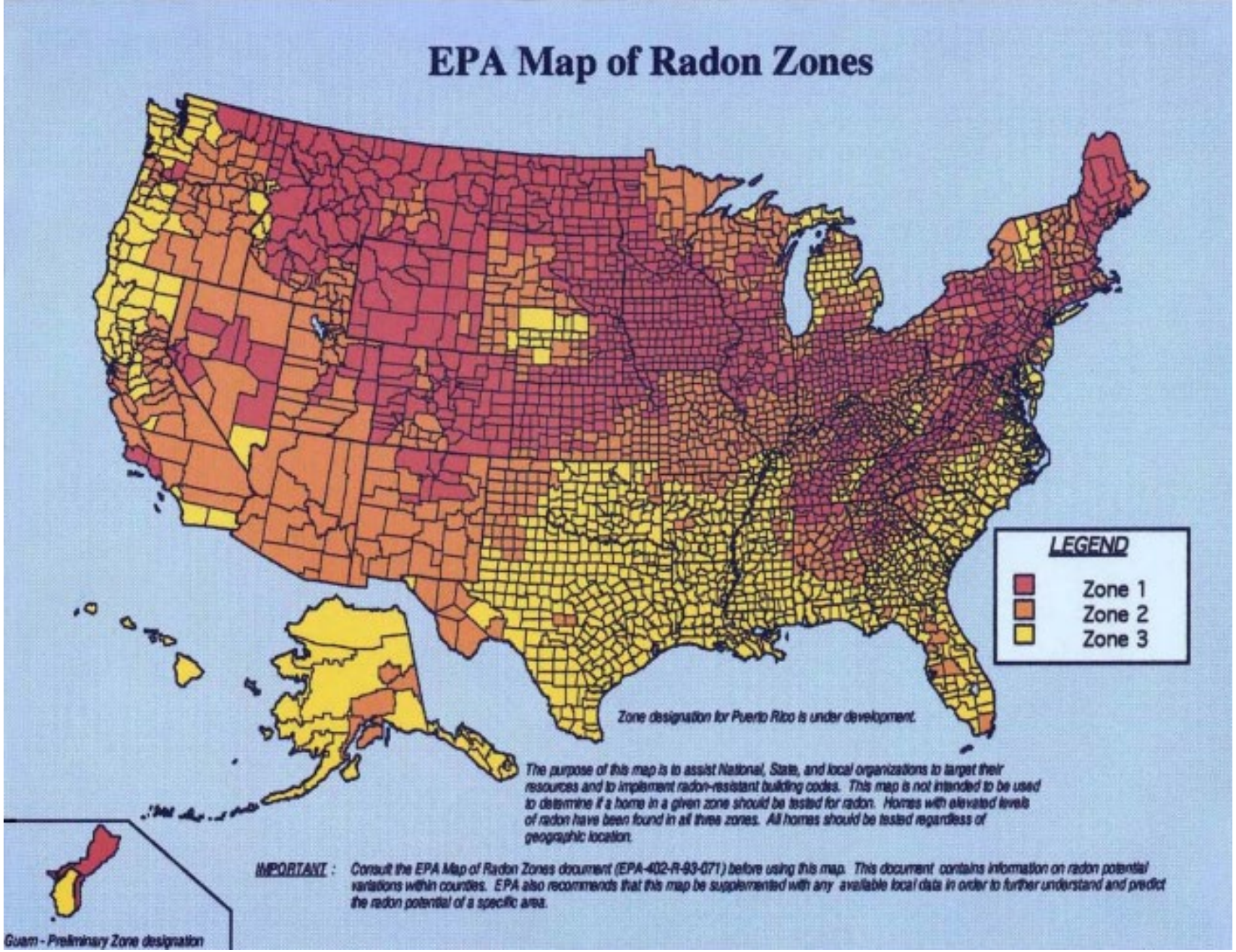
Example 1: Kinetics of Radioactive Decay

The half-life of cobalt-60 is 5.3 yr. How much of a 1.000-mg sample of cobalt-60 is left after 15.9 yr?

Example 2: Kinetics of Radioactive Decay

A wooden object from an archeological site is subjected to radiocarbon dating. The activity of the sample that is due to ^{14}C is measured to be 11.6 disintegrations per second. The activity of a carbon sample of equal mass from fresh wood is 15.2 disintegrations per second. The half-life of ^{14}C is 5715 yr. What is the age of the archeological sample?

Potassium ion is present in foods and is an essential nutrient in the human body. One of the naturally occurring isotopes of potassium, potassium-40, is radioactive. Potassium-40 has a natural abundance of 0.0117% and a half-life $t_{1/2}$ = 1.28 x 10^9 yr. It undergoes radioactive decay in three ways: 98.2% is by electron capture, 1.35% is by beta emission, and 0.49% is by positron emission. **(a)** Why should we expect ^{40}K to be radioactive? **(b)** Write the nuclear equations for the three modes by which ^{40}K decays. **(c)** How many $^{40}K^+$ ions are present in 1.00 g of KCl? **(d)** How long does it take for 1.00% of the ^{40}K in a sample to undergo radioactive decay?



https://www.epa.gov/radon/epa-map-radon-zones-0