

Nuclear Decay

SECTION 2

NUCLEAR DECAY MODES

So far, we have considered what happens when nucleons are bound together to form stable nuclei. However, not all nuclei are stable. There are about 400 stable nuclei; hundreds of others are unstable and tend to break apart into other particles. This process is called *nuclear decay*.

The nuclear decay process can be a natural event or can be induced artificially. In either case, when a nucleus decays, radiation is emitted in the form of particles, photons, or both. The emission of particles and photons is called *radiation*, and the process is called *radioactivity*. For example, the hands and numbers of the watch shown in **Figure 4** contain small amounts of radium salts. The nuclei within these salts decay, releasing light energy that causes the watch to glow in the dark. The nucleus before decay is called the *parent nucleus*, and the nucleus remaining after decay is called the *daughter nucleus*. In all nuclear reactions, the energy released is found by the equation $E = \Delta mc^2$.

A radioactive material can emit three types of radiation

Three types of radiation can be emitted by a nucleus as it undergoes radioactive decay: alpha (α) particles, in which the emitted particles are ${}^4_2\text{He}$ nuclei; beta (β) particles, in which the emitted particles are either electrons or positrons (positively charged particles with a mass equal to that of the electron); and gamma (γ) rays, in which the emitted “rays” are high-energy photons. These three types of radiation are summarized in **Table 3**.

Table 3 Alpha, Beta, and Gamma Radiation

Particle	Symbols	Composition	Charge	Effect on parent nucleus
alpha	α (${}^4_2\text{He}$)	2 protons, 2 neutrons	+2	mass loss; new element produced
beta	β^- (${}^0_{-1}e$)	electron	-1	no change in mass number; new element produced
	β^+ (${}^0_{+1}e$)	positron	+1	
gamma	γ	photon	0	energy loss

SECTION OBJECTIVES

- Describe the three modes of nuclear decay.
- Predict the products of nuclear decay.
- Calculate the decay constant and the half-life of a radioactive substance.

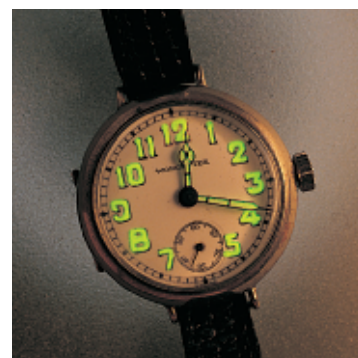


Figure 4

The radioactive decay of radium nuclei causes the hands and numbers of this watch to glow in the dark.