Nuclear Equations

When the nucleus of a radioisotope (radionuclide) emits an alpha-particle (α), it loses 4 nucleons: 2 protons + 2 neutrons. $\alpha = {}^{4}_{2}\mathrm{He}$

When a nucleus emits a beta-particle (β), it emits an electron. This happens because a neutron has changed into a proton and an electron (which is emitted). $\beta = {}^{0}_{-1}\mathrm{e}$

In each case the nuclear equation must balance.
The top number is the nucleon number (mass number).
The bottom number is the proton number (atomic number).

Examples
Write the nuclear equations for:
a) Radium-226 decays by α-emission.
b) Polonium-218 decays by β-emission.
(See page 345.)

Answers
a) ${}^{226}_{88}\mathrm{Ra} \longrightarrow {}^{222}_{86}\mathrm{Rn} + {}^{4}_{2}\mathrm{He}$
b) ${}^{218}_{84}\mathrm{Po} \longrightarrow {}^{218}_{85}\mathrm{At} + {}^{0}_{-1}\mathrm{e}$

Questions
You may need the information in this table:

Atomic (proton) number:	92	91	90	89	88	87	84	82
Element name:	Uranium	Protactinium	Thorium	Actinium	Radium	Francium	Polonium	Lead
Element symbol:	U	Pa	Th	Ac	Ra	Fr	Po	Pb

1. For each of the following, write down a balanced nuclear equation.
   a) ${}^{238}_{92}\mathrm{U}$ decays by α-emission
   b) ${}^{228}_{90}\mathrm{Th}$ decays by α-emission
   c) ${}^{218}_{84}\mathrm{Po}$ decays by α-emission
   d) ${}^{223}_{87}\mathrm{Fr}$ changes by β-decay
   e) ${}^{227}_{89}\mathrm{Ac}$ decays by β-emission
   f) ${}^{234}_{90}\mathrm{Th}$ decays by β-emission

2. The uranium isotope ${}^{238}_{92}\mathrm{U}$ decays in a series of stages: ${}^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th} \rightarrow {}^{234}_{91}\mathrm{Pa} \rightarrow {}^{234}_{92}\mathrm{U} \rightarrow {}^{230}_{90}\mathrm{Th} \rightarrow {}^{226}_{88}\mathrm{Ra} \rightarrow$
   a) Which particles are emitted at each of the five stages?
   b) What other kind of nuclear radiation is emitted at all five stages?

3. The radionuclide ${}^{232}_{90}\mathrm{Th}$ emits a particle and decays to ${}^{228}_{88}\mathrm{Ra}$.
   a) Write down the equation, and
   b) Explain what has happened.

4. The radionuclide ${}^{14}_{6}\mathrm{C}$ of carbon emits a particle and decays to ${}^{14}_{7}\mathrm{N}$ (nitrogen).
   a) Write down the equation, and
   b) Explain what has happened.