

SCIENCE 10

RADIOACTIVE DECAY

Learning Outcomes:

- I can describe some of the properties of the three types of radiation (alpha, beta and gamma radiation).
- I can complete radioactive equations.

Radioactivity

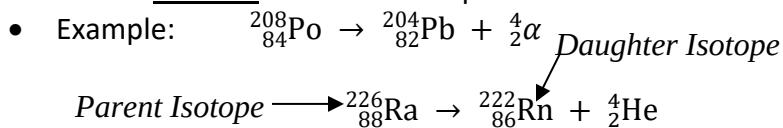
- the release of energy as a result of changes in the nuclei of an atom
- scientists discovered that when radioactive energy was given off, the atoms of one type of element were changed into the atoms of another type of element
- isotopes that are unstable become stable by losing energy by emitting radiation
 - this process of giving off radiation is called radioactive decay
 - when an atom of an element decays, it usually turns into a different type of atom

Types of Radiation

- TEACHER NOTE: While working at McGill University in Montreal, Ernest Rutherford discovered that there are three common types of radiation*

1. Alpha Radiation

- a stream of alpha particles → called alpha decay
- alpha particle is the same as the nucleus of a helium atom (${}^4_2\text{He}$ or ${}^4_2\alpha$)
- because there is only 2 protons and 2 neutrons present, an alpha particle has a charge of +2
- largest and most massive type of radiation
 - relatively slow moving
 - does not penetrate through other objects → can be stopped by a sheet of paper
- since 2 protons are given off, a different type of element is formed with an atomic number 2 less than the parent atom



Practice Problems

- ${}^{208}_{84}\text{Po} \rightarrow {}^{204}_{82}\text{Pb} + {}^4_2\alpha$
- ${}^{231}_{91}\text{Pa} \rightarrow {}^{227}_{89}\text{Ac} + {}^4_2\text{He}$
- ${}^{225}_{89}\text{Ac} \rightarrow {}^{221}_{87}\text{Fr} + {}^4_2\alpha$
- ${}^{196}_{79}\text{Au} \rightarrow {}^{192}_{77}\text{Ir} + {}^4_2\alpha$
- ${}^{211}_{87}\text{Fr} \rightarrow {}^{207}_{85}\text{At} + {}^4_2\text{He}$

2. Beta Radiation

- a beta particle is equal to a high energy electron → called beta decay
- written as ${}^0_{-1}e$ or ${}^0_{-1}\beta$
- has a charge of -1
- lightweight and fast moving
 - can penetrate more than an alpha particle
 - can be stopped by a sheet of aluminum foil
- the electron comes from the breakdown of a neutron → forms an electron and a proton → increases the atomic number by 1
- example:
$${}^{14}_6\text{C} \rightarrow {}^{14}_7\text{N} + {}^0_{-1}\beta$$
$${}^{131}_{53}\text{I} \rightarrow {}^{131}_{54}\text{Xe} + {}^0_{-1}e$$

Practice Problems

- ${}^{14}_6\text{C} \rightarrow {}^{14}_7\text{N} + {}^0_{-1}\beta$
- ${}^6_2\text{He} \rightarrow {}^6_3\text{Li} + {}^0_{-1}\beta$
- ${}^{24}_{11}\text{Na} \rightarrow {}^{24}_{12}\text{Mg} + {}^0_{-1}e$
- ${}^{201}_{79}\text{Au} \rightarrow {}^{201}_{80}\text{Hg} + {}^0_{-1}\beta$
- ${}^{52}_{26}\text{Fe} \rightarrow {}^{52}_{27}\text{Co} + {}^0_{-1}\beta$
- ${}^{42}_{19}\text{K} \rightarrow {}^{42}_{20}\text{Ca} + {}^0_{-1}e$

3. Gamma Radiation

- a ray of high-energy, short wavelength radiation → called gamma decay
 - results when the nucleus of an atom has too much energy
- written as ${}^0_0\gamma$
- has almost no mass and no charge
 - has great penetrating power
 - need thick blocks of dense material (lead or concrete) to stop it
- does not result in the formation of a new atom
- example: ${}^{60}_{28}\text{Ni}^* \rightarrow {}^{60}_{28}\text{Ni} + {}^0_0\gamma$ the * means extra energy in the nucleus of the isotope
- gamma decay can result when other types of radioactive decay result in a new atom with too much energy in the nucleus
- example:
$${}^{238}_{92}\text{U} \rightarrow {}^{234}_{90}\text{Th}^* + {}^4_2\alpha$$
then
$${}^{234}_{90}\text{Th}^* \rightarrow {}^{234}_{90}\text{Th} + {}^0_0\gamma$$