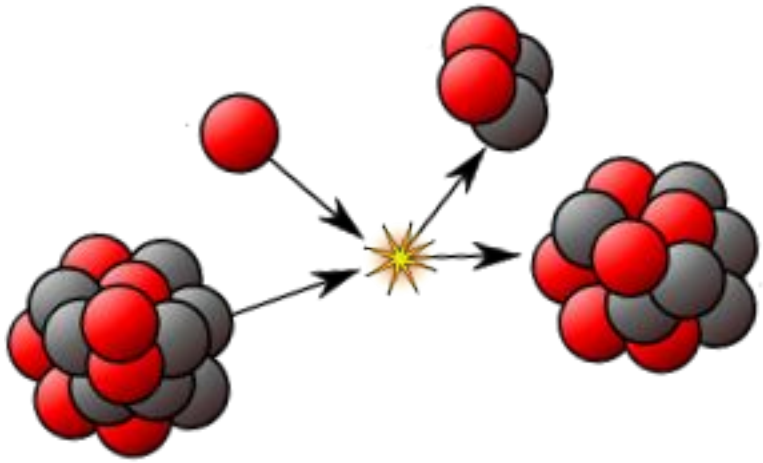
NOTES on Chapter 4: Elements and the Periodic Table

4.5 Radioactive Elements

RADIOACTIVITY

Atoms with the same number of protons and different number of neutrons are called <u>isotopes</u>.

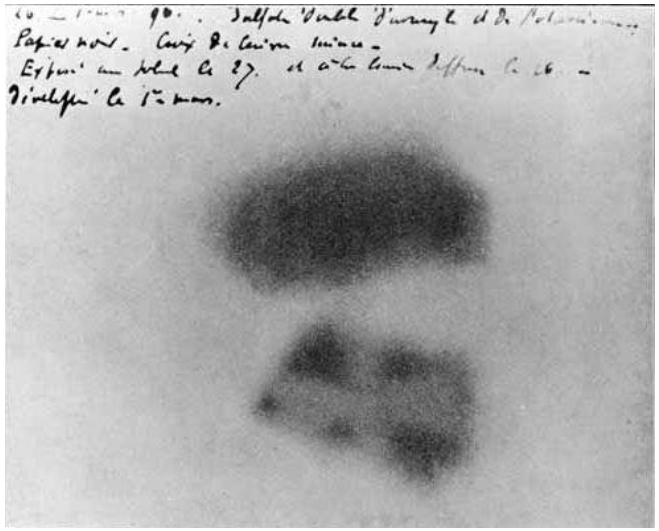
Some isotopes are unstable, which means their nuclei does not hold together very well. During radioactive decay, that unstable nuclei will release fast-moving particles and energy.



Henri Becquerel, in 1896, discovered the effects of radioactive decay by accident while studying a mineral that contained uranium.
He found that the mineral would give off energy when exposed to sunlight, so he assumed that the process needed sunlight.
When the day became cloudy, he placed his sample in a drawer right next to a photographic plate wrapped in paper.

Imagine his surprise when he took the sample out from his desk drawer to find an image of the mineral sample on the photographic plate.

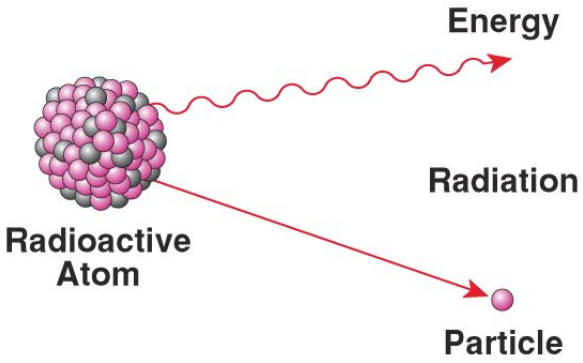
Sunlight wasn't needed at all. He hypothesized that uranium must spontaneously give off energy, called radiation. What was the source of this energy?

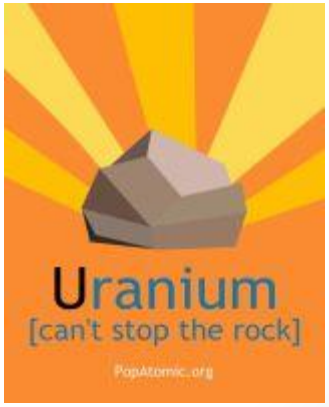


Becquerel presented his findings to a young researcher, Marie Curie and her husband, Pierre.

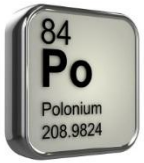
After a great deal of research, they determined that a reaction was taking place within the nuclei of uranium.

Radioactivity is what Marie Curie called this spontaneous emission of radiation by an unstable atomic nucleus.





Marie Curie was not finished! She observed that some minerals containing uranium were even MORE radioactive than pure uranium. Through countless hours of experimentation, she discovered the cause. There were other highly radioactive elements within the samples of minerals. Madame Curie was able to isolate two new elements, polonium and radium.



Word origin: Polonium is named after the country of Poland, the native home of chemist Marie Curie.

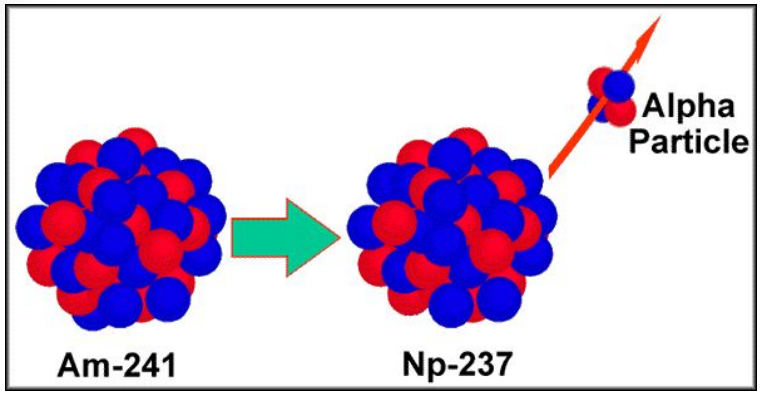
Polonium has few commercial applications because of its radioactive nature. The element has been used in devices to eliminate static charge for textiles and on brushes to remove dust on photographic film.
Polonium is also used as a lightweight heat source for thermoelectric power in space satellites because a small amount of the element can release a large amount of energy.

Word origin: The word radium comes from *radius*, the Latin word for rays.

Uses: Radium has been used to produce neutron sources, luminous paints, and medical radioisotopes.

Natural radioactive decay can produce 3 types of particles:

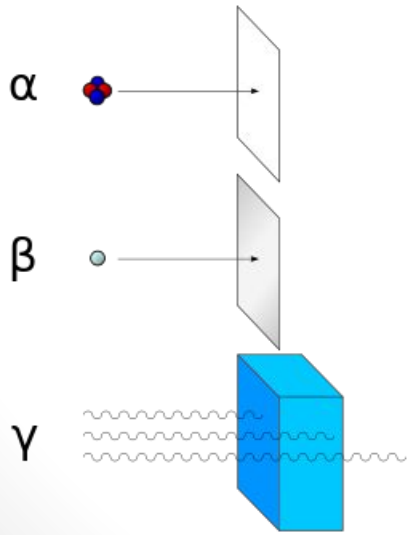
1. ALPHA PARTICLE



An alpha particle consists of 2 protons and 2 neutrons. It is positively charged.

This is the same as losing a helium without the shell.

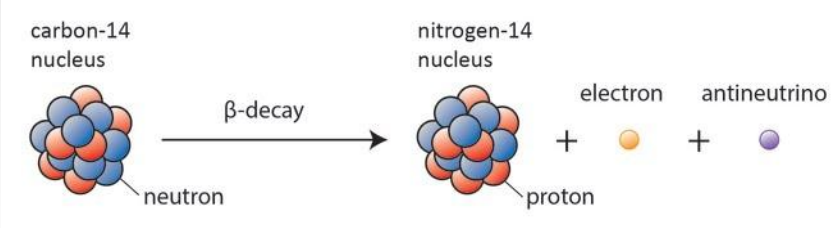
The atomic number decreases by 2 and atomic mass by 4.



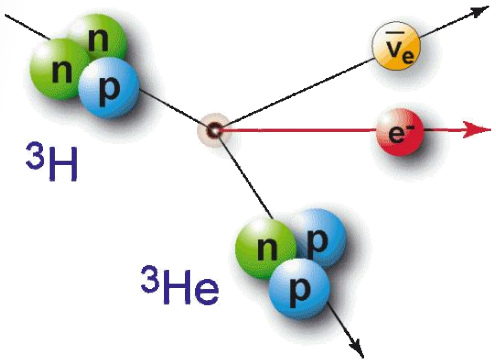
Alpha particles move fast, but can be stopped by a piece of paper.

They can cause a burn to human skin.

Natural radioactive decay can also produce beta particles.



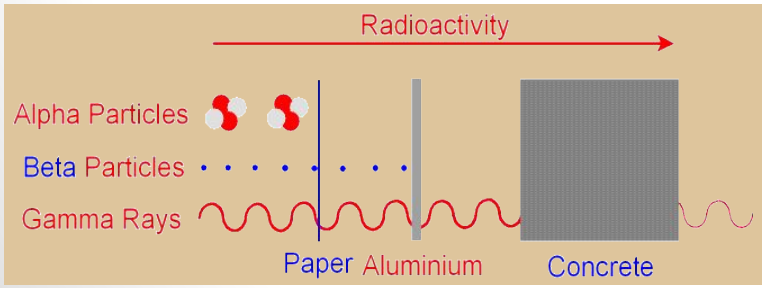
Some atoms become unstable because they have too many neutrons in their nucleus. In beta decay, a neutron changes into a negatively charged beta particle and a proton.



A beta particle is a fast-moving electron given off during decay.

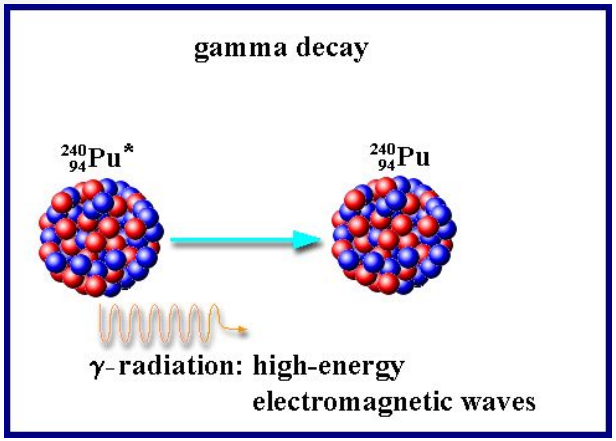
The new protons stays in the nucleus. Now, the nucleus has 1 less neutron, but 1 more proton.

The atomic number increases by 1, but the atomic mass stays the same.



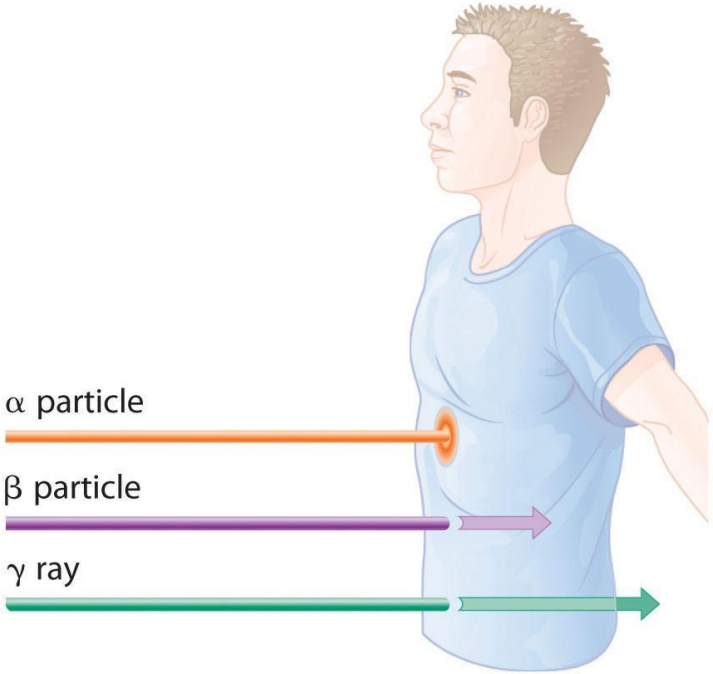
Beta particles are faster and more penetrating than alpha. They pass through the paper but are blocked by 5mm sheet of aluminum. These can travel into the body and damage cells.

The third type of nuclear radiation produced during radioactive decay is **gamma radiation.**



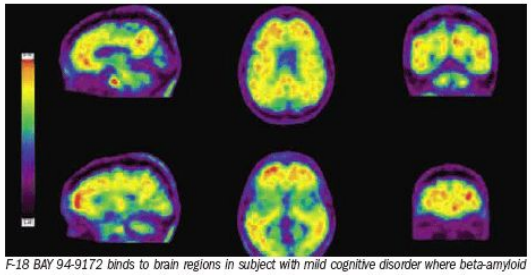
In both alpha and beta decay, high-energy waves are given off.
Gamma radiation does not cause a change in either the atomic mass or atomic number.

It would take several centimeters of lead or a concrete wall to stop gamma rays. These can pass right through a body, causing intense damage to cells because of the amount of energy hitting them.

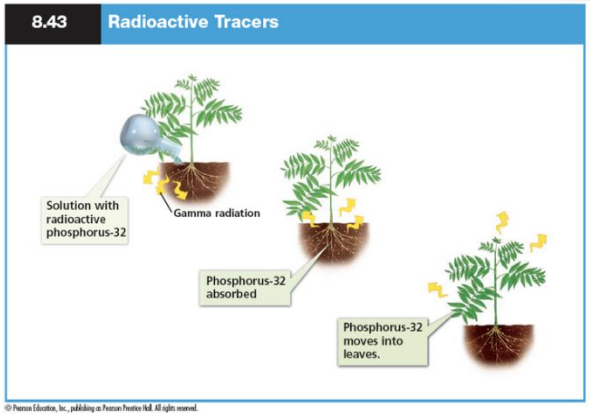


Uses of Radioactive Isotopes

FIGURE 40
Radioactive Isotopes in Medicine
Front and back body scans of a healthy patient were made using a radioactive isotope.



F-18 BAY 94-9172 binds to brain regions in subject with mild cognitive disorder where beta-amyloid plaques typically accumulate in Alzheimer's patients. Corresponding with yellow and red areas, they include the frontal cortex, posterior cingulate, precuneus, lateral parietal, and lateral temporal cortex. (Provided by C. Rowe)



TRACERS in medicine and business.