

Radioactivity : W.S.-20

In 1896 Henri Becquerel found that uranium emitted radiation. This was the discovery of **radioactivity**.

Radioactivity is produced by atoms that have unstable nuclei. These nuclei become stable by emitting radiation.

The nuclei of radioactive atoms can emit three types of radiation. These are; alpha particles (helium nuclei He^{2+}), beta particles (electrons), and gamma rays (high energy electromagnetic waves).

Alpha particles can be stopped by a piece of paper. Beta particles can be stopped by a piece of aluminum that is 1.0 mm thick. Gamma rays can be stopped by several centimeters of lead.

These particles can be dangerous. They can cause burns and damage to D.N.A. This can lead to mutations.

When a radioactive atom emits one particle per second, then it is said to have an activity of one becquerel (Bq).

Radioactive Emissions

Name	Charge	Mass (a.m.u.)	Structure
Alpha particle	+2	4	helium nuclei
Beta particle	-1	0.0005	electron
Gamma ray	0	0	wave/electromagnetic

Note: The a.m.u. is a unit of mass approximately equal to the mass of a proton or a neutron.

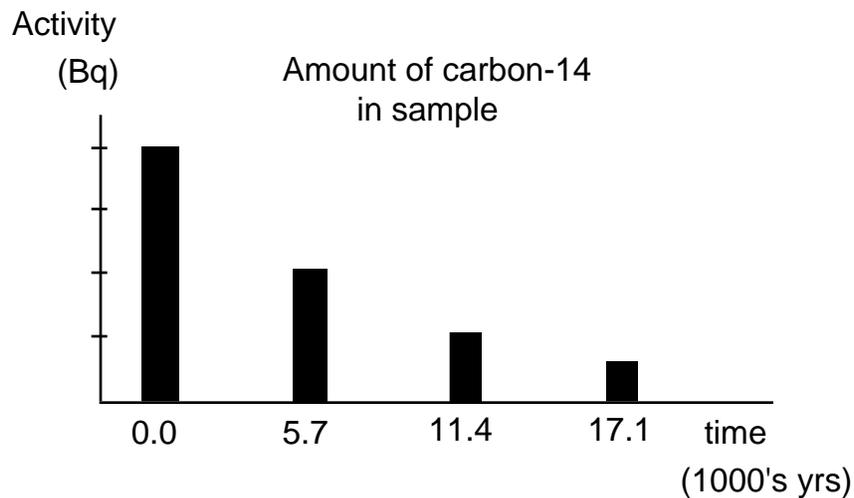
Isotopes

Isotopes are atoms with differing numbers of neutrons. For example carbon has two important isotopes; carbon-12, and carbon-14. All carbon atoms have six protons (the number of protons equals the atomic number) but carbon-12 has six neutrons and carbon-14 has eight neutrons in the nucleus.

Most carbon atoms are carbon-12 atoms which are stable. The carbon-14 atom is radioactive. This means that it will decay (by beta emission). Carbon-14 is called a radioactive isotope or a radioisotope.

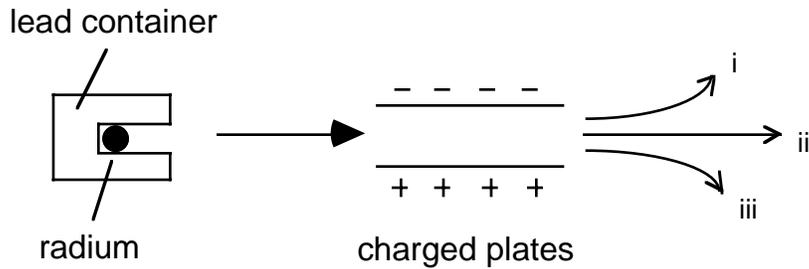
Radioactive Isotopes

In the case of carbon-14, we find that in any sample of this atom, half of the atoms will decay in 5700 years. This is the **half-life** of carbon-14. For example, if we have 0.64 grams of carbon-14 now, in 5,700 years we will have 0.32 grams. In 11,400 years (2×5700) we will have 0.16 grams. By comparing the amount of carbon-14 with the amount of other atoms in a sample, we can find the age of the sample. This method can be used to find the age of a piece of wood. All trees are made of carbon, both carbon-12 and carbon-14. But after the tree dies, the carbon-14 changes into other atoms.



Problems:

- 1) What is radioactivity?
- 2) Who discovered radioactivity?
- 3) Name the three types of radiation produced by radioactive atoms.
- 4) Alpha particles, beta particles, and gamma rays are emitted by radioactive radium. When these radiations pass through a pair of charged plates, each type is deflected differently.



a) Which radiation is found at i, ii, and iii above? (hint: note the charge on each type)

b) Which type of radiation has the highest energy?

c) Why is the radium kept in a lead container?

5) What is an isotope?

6)a) What is the half-life of the radioactive isotope, carbon-14?

b) If we have a sample of 8.0 grams of carbon-14, how much will be left in 17,100 years?

7) Suppose that you have 64 grams of a radioactive isotope at time $t = 0.0$ hrs. The half-life is 4.0 hours. Give the amount remaining after the following times.

a) $t = 4.0$ hours

b) $t = 8.0$ hours

c) $t = 16$ hours

d) $t = 32$ hours

Answers: 1) It is the decay of the nuclei of unstable atoms., 2) Becquerel, 3) alpha, beta, and gamma., 4)a) i) alpha, ii) gamma, iii) beta, b) gamma, c) It is to protect you from gamma rays! Lead can stop gamma rays, 5) Isotopes are elements with differing numbers of neutrons., 6)a) 5,700 years, b) 1.0 gram, 7)a) 32 g, b) 16 g, c) 4.0 g, d) 0.25 g.