Aesthetic and Laser Techniques Department

First Semester

General Chemistry (2024-2025) lecture (3)

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Radioactivity and radioactive isotopes.

Radioactivity: -

Radioactivity - spontaneous decay of the nucleus of an atom by the emission of particles, usually accompanied by electromagnetic radiation. It is also defined as the mean number of nuclear transformations occurring in a given quantity of radioactive material per unit time, expressed in either becquerels (Bq) or curies (Ci).

Most radionuclides have multiple forms of radioactive emissions, and are classified according to their principal decay modes. The most common types of radiation are Alpha, Beta and Gamma radiation.

Atoms with unstable nuclei are constantly changing as a result of the imbalance of energy within the nucleus. The unstable nucleus will emit energy in some form and is said to be radioactive. Radioactivity is the release of energy or ejection of matter that results from changes in the nucleus of an atom. -

Atoms which are energetically unstable and decay to a stable condition by emitting radiation are said to be radioactive.

Radioisotopes; –

As the unstable nucleus changes, it gives off radiation and is said to be radioactive. Radioactive isotopes are often called radioisotopes Radioisotopes - elements that are atomically unstable and radioactive.

All elements with atomic numbers greater than 83 are radioisotopes meaning that these elements have unstable nuclei and are radioactive

Elements with atomic numbers of 83 and less, have isotopes (stable nucleus) and most have at least one radioisotope (unstable nucleus).

As a radioisotope tries to stabilize, it may transform into a new element in a process called transmutation - (The change of one element into another as a result of changes within the nucleus).

Remember that a radioisotope has unstable nuclei that does not have enough binding energy to hold the nucleus together.

Radioisotopes would like to be stable isotopes so they are constantly changing to try and stabilize.

Isotope: -

Isotope - One of two or more atoms of the same element that have the same number of protons in their nucleus but different numbers of neutrons. Most elements have more than one naturally occurring isotope.

Isotopes are variants of an element that, while all having the same number of protons, have differing numbers of neutrons. These variants are called isotopes. Elements that are atomically unstable and radioactive.

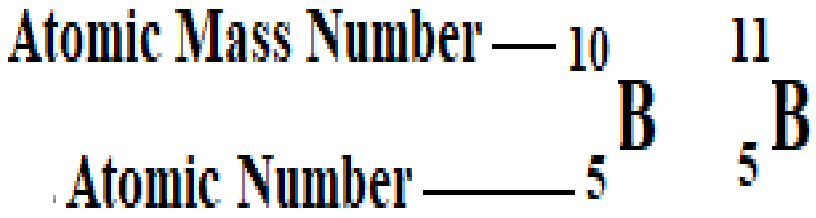
Because the like charges of the protons repel each other, these forces are always trying to push the atom's nucleus apart. The nucleus is held together by something called the binding energy.

In most cases, elements like to have roughly the same number of protons and neutrons because this makes them the most stable.

Stable atoms have a binding energy that is strong enough to hold the protons and neutrons together.

Even if an atom has an additional neutron or two it may remain stable. However, each additional neutron may upset the balance and cause the atom to become unstable. In an unstable atom, the nucleus changes its configuration by giving off matter of energy to get to a balanced state. Atomic mass number

We can quickly distinguish between isotopes by representing each isotope using nuclide notation for example



Radioactive decay; -

Radioactive Decay - The process by which the nucleus of a radioactive isotope decomposes and releases radioactivity. Radioactive decay is the spontaneous breakdown of an atomic nucleus resulting in the release of energy and matter from the nucleus.

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Radioactive decay is the spontaneous change of an unstable atom into a stable form, by releasing energy and matter from the nucleus.

The radioactive decay and transmutation process will continue until a new element is formed that has a stable nucleus and is not radioactive.

Definitions of some important terms:-

In the process, they will release energy and matter from their nucleus and often transform into a new element. This process, called transmutation, is the change of one element into another as a result of changes within the nucleus.

Nuclear Reaction - A reaction involving an atom's nucleus, such as fission, neutron capture, radioactive decay, or fusion, as distinct from a chemical reaction, which is limited to changes in the electron structure surrounding the nucleus.

Nucleus - The center of an atom containing protons and neutrons.

Atomic Number - A number representing the positive charge or number of protons in the nucleus of an atom.,

The Atomic mass number, which describes the number of protons and neutrons, is attached at the upper left of the symbol.

Half-lives: -

Is the time required for one half the atoms in a radioactive substance to decay. Can also know the term half-life describes how long it will take for half of the atoms to decay, and is constant for a given isotope.

For example, the radioactive half-life of cesium is 30.174 years. Radionuclides with short half-lives decay quickly and radionuclides with longer half-lives emit energy over longer periods of time.

A table showing some of the elements that have isotopes and the half-life of each element

Radioisotope	Half-life
Polonium-215	0.0018 seconds
Bismuth-212	60.5 seconds
Sodium-24	15 hours
Iodine-131	8.07 days
Cobalt-60	5.26 years
Radium-226	1600 years
Uranium-238	4.5 billion years

Questions with answers: -

What is the difference between isotopes and radioactivity?

Radioactivity is the release of energy and matter due to a change in the nucleus of an atom.

Radioisotopes are isotopes that are unstable and release radiation. All isotopes are not radioisotopes. Transmutation occurs when a radioactive element attempts to become stabilized and transforms into a new element.

What is radiation and radioisotopes?

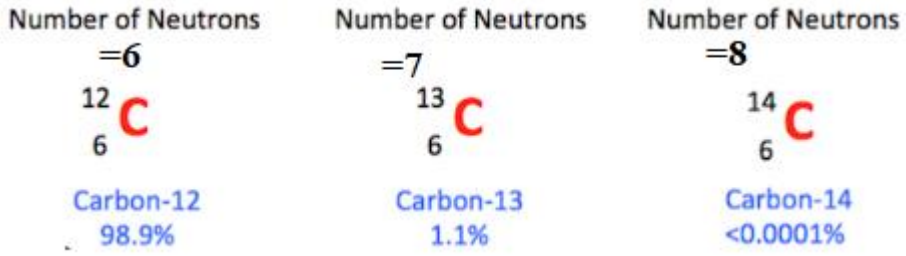
Radioisotopes are the unstable form of an element that emit radiation to transform into a more stable form. Radiation is easily traceable and can cause changes in the substance it falls upon. These special attributes make radioisotopes useful in medicine, industry and other areas.

What is the radioactivity of an isotope?

A radioactive isotope, also known as a radioisotope, radionuclide, or radioactive nuclide, is any of several species of the same chemical element with different masses whose nuclei are unstable and dissipate excess energy by spontaneously emitting radiation in the form of alpha, beta, and gamma rays.

How many isotopes of the element carbon atom?

Isotopes are different species of atoms of an element that have different atomic masses. For example, there are three isotopes of carbon: Carbon-12, Carbon-13, and Carbon-14. They have atomic masses of 12, 13, and 14, respectively.



What are isotopes and examples?

Examples of radioactive isotopes include carbon-14, tritium (hydrogen-3), chlorine-36, uranium-235, and uranium-238. Some isotopes are known to have extremely long half-lives (in the order of hundreds of millions of years). Such isotopes are commonly referred to as stable nuclides or stable isotopes.

What are three uses of radioactive isotopes?

Tracer Applications.

Irradiation of Food and Mail.

Smoke Detectors.

Other ApplicationsRadioisotopes: Tools in Radiopharmaceutical Sciences.

Which definition best describes a radioactive isotope?

Radioactive isotopes are isotopes that exhibit unstable nuclei and undergo radioactive decay, emitting radiation in the process.

What are the of radioactivity?

Uses in benefit humankind, radiation is used in medicine, academics, and industry, as well as for generating electricity. In addition, radiation has useful applications in such areas as agriculture, archaeology (carbon dating), space exploration, law enforcement, geology (including mining), and many others.

what is the difference between radioactive and radioisotopes?

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What-are-the-differences-between-radioactive-decay-and-radiationA nucleus that is unstable is called radioactive?

A radioactive nucleus reaches a stable state through radioactive decay.

A radioactive nucleus decays by emitting radiation.

The radiation can be of several types, most likely alpha, beta, or gamma.

The process of decay can be called radioactivity.