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Types of Radiation Guided Notes – Student Edition

Radioactive decay

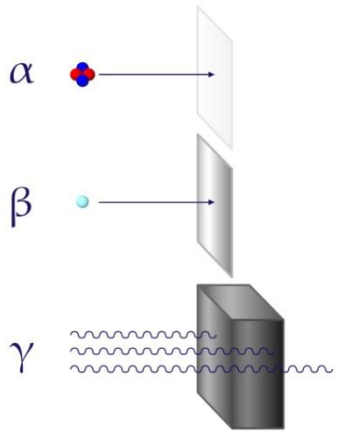
Radioactive decay is defined as the process by which an _____ nucleus loses energy through the emission of _____or electromagnetic _____. The emitted particles or electromagnetic waves are called _____, and the decaying nucleus is called _____. The result of radioactive decay is the transmutation (_____) or the nucleus into a different isotope.

Certain elements are far more radioactive than others. Isotopes tend to be less stable because they contain a larger number of _____than 'non-isotopes' of the same element. These radioactive isotopes are called _____.

Radiation can be emitted in different forms. There are three main types of radiation:

- Alpha (__) radiation
- Beta (__) radiation
- Gamma (__) radiation

Radiation can be classified based on its ability to _____solid material. This is known as its _____. The penetration power of the three types of radiation is shown in the diagram below.



Alpha (α) particles and decay

An alpha particle consists of _____ protons and _____ neutrons bound together. Alpha particles have a _____ charge and are sometimes represented by the chemical symbol _____ because it has the same structure as a _____ atom (two neutrons and two protons). An alpha particle is _____ the two electrons; hence, it has an overall charge of _____ 2.

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Compared to other types of radiation, _____ particles have very _____penetration power which means that a thin as a piece of _____ or the _____of the human skin, will absorb these particles preventing them from travelling any further.
A nucleus will decay by alpha emission when it has too many _____, which is causing the _____ force (the force of repulsion between the like charges) to exceed the _____force. In an attempt to reduce this repulsion and balance the nuclear forces, the nucleus emits an _____ particle as is seen in the equation below.

Example: The decay of Americium (Am) to Neptunium (Np)

$$^{241}_{95}Am \rightarrow {}^{237}_{93}Np + {}^{4}_{2}He$$

In this reaction, Americium (Z = _____; A =____) undergoes alpha decay releasing an alpha particle (i.e. 2 protons and 2 neutrons). The atom now has ____ protons (Z = 93). On the periodic table, the element which has 93 protons (Z = 93) is _____. Therefore, the Americium atom has become a Neptunium atom. The atomic mass of the neptunium atom is ____ (A = 237) because ____ nucleons (2 protons and 2 neutrons) were emitted from the atom of Americium.

Beta (β) particles and decay

Beta emission is another common _____ process which occurs when there are too many _____. In this case, a neutron may be converted into a _____, an _____ and another particle (called a _____). The high energy electrons that are emitted in this way are called _____. Beta particles have a _____ penetration power when compared to alpha particles and can pass through _____ materials such as paper but are blocked by a sheet of thin metal, such as _____.

In beta decay, the number of neutrons in the atom decreases by _____, and the number of protons increases by _____. Beta-decay also releases an _____. Since the number of protons before and after the decay is different, the atom changes (_____) into a different element. The example below shows beta decay of a hydrogen atom to become _____, releasing an electron and a neutrino.

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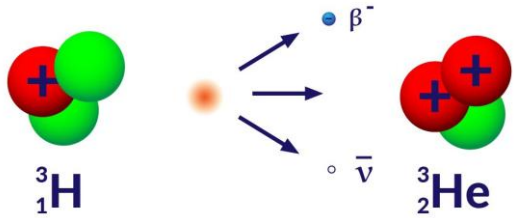


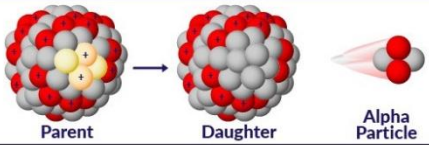
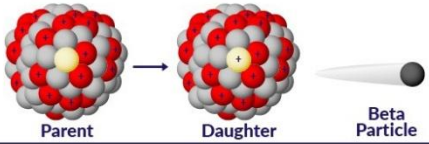
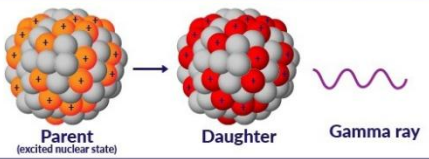
Gamma (γ) rays and gamma decay

Gamma rays are _____waves which have the highest power of penetration. This type of radiation can penetrate most common substances, including _____. The only substances that can absorb this radiation are _____and _____. Gamma radiation is part of the electromagnetic _____, just like visible light. However, unlike visible light, humans cannot see gamma rays because they are of a higher _____ and energy.

Gamma-ray production accompanies nuclear reactions of all types and occurs if the nucleus is at too _____ an energy level. Since gamma rays are part of the _____ spectrum, they can be thought of as waves or particles. Gamma radiation has no _____ or _____. Therefore, in gamma decay, a ray or a particle (called a _____) is released, but the _____and _____ remain the same. For example, when uranium-238 decays by emitting an alpha particle, two gamma rays are also emitted.

Radioactive Decay Equations

We can find out what happens when an isotope decays by writing a balanced equation for the decay.

Decay Type	Generic Equation	Model
Alpha decay	${}^{A}_{Z}X \longrightarrow {}^{A-4}_{Z-2}X' + {}^{4}_{2}\alpha$	
Beta decay	${}^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}X' + {}^{0}_{-1}\beta$	
Gamma emmission	${}^{A}_{Z}X^{*} \xrightarrow{\text{Relaxation}} {}^{A}_{Z}X' + {}^{0}_{0}\gamma$	

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The steps to working out these equations are shown below:

Example Question:

Plutonium – 239 undergoes radioactive decay by emitting an alpha particle. Write an equation for this decay process.

Answer:

Step 1: Work out the number of protons and/or neutrons that the isotope loses during its radioactive decay.

Note: in some questions, a radioisotope may lose more than one particle so the total number of protons and neutrons must be added up.

Step 2: Calculate the atomic number (Z) and atomic mass number (A) of the element that is formed.

Step 3: Refer to the periodic table to identify the element with the atomic number that you have calculated.

Step 4: Write the equation for the decay process.

Practice Question:

Write the equations for the following elements when they decay.

1. Uranium-238 by alpha decay

   Answer:

   Explanation:

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2. Carbon-14 by beta emission

   Answer:

   Explanation:

3. Thorium-230 by alpha decay

   Answer:

   Explanation:

4. Strontium-90 by beta decay

   Answer:

   Explanation: