Types of nuclear radiation worksheet

Alpha particles are made up of 2 protons and 2 neutrons. This means that they have a charge of +2, and mass 4 (mass is measured in atomic mass units, where each proton and neutron =1) we can write it as, or, because it is the same helium nucleus, . Alpha particles are relatively slow and heavy. They have low penetration power - you can stop them with just paper. Because they have a large charge, alpha particles strongly ionize other atoms. Learning objectives qualitatively compare the ionizing force and penetration of alpha particles (\left)\\alpha\ Express changes in the atomic number and the mass number of radioactive nuclei when alpha, beta or gamma particles are emitted. Write the nuclear equations for alpha and beta-decay reactions. Many nuclei are radioactive; That is, they decompose by emitting molecules and thus become a different nucleus. In our studies up to this point, atoms of a single element have not been able to change into different elements. That's because in all other types of changes we talked about electrons just were changing. In these changes, the nucleus, which contains protons that dictate any element that is an atom, changes. All nuclei with 84 or more radioactive protons and elements with less than 84 protons have both stable and unstable isotopes. All of these elements can undergo nuclear changes and turn into different elements. In natural radioactive decay, three common emissions occur. When these emissions were originally observed, scientists were unable to identify them as some of the already known particles and thus named the first three letters of the Greek alphabet. Later, alpha molecules were identified as helium-4 nucleus, and beta molecules were identified as electrons, and gamma rays as a form of electromagnetic radiation such as X-rays except for much higher energy and more dangerous on living systems. With all the radiation from natural and man-made sources, we should be reasonably concerned about how all radiation affects our health. Damage to living systems is caused by radioactive emissions when particles or rays strike and change tissues, cells or molecules. These interactions can change molecular structure and function; Large amounts of radiation are very dangerous, even deadly. In most cases, radiation will damage one (or a very small number) of cells by breaking the cell wall or otherwise preventing a cell from multiplying. The ability of radiation to damage molecules is analysed in terms of so-called ionizing energy. When a particle of radiation interacts with atoms, the atom can cause the atom to lose And so it becomes ionizing. The more likely the damage will be caused by interaction is the ionizing force of the radiation. Most of the threat from radiation involves the ease or difficulty of protecting oneself from particles. How thick of the wall do you need to hide behind to be safe? The ability of each type of radiation to pass through matter is expressed in terms of penetration power. The more material the radiation can go through, the greater the penetration force and the more dangerous it will be. In general, the larger mass is present, the greater the ionizing force, and the lower the penetration force. By comparing only the three common types of ionizing radiation, alpha particles have the largest mass. Alpha particles have nearly four times the mass of a proton or neutron and about 8,000 times the mass of a beta particle. Because of the large mass of alpha particles, it has the highest ionizing force and the greatest ability to damage tissues. This same large size of alpha molecules, however, makes them less capable of penetrating matter. They collide with molecules very quickly when they hit the material, add two electrons, and the helium atom becomes harmless. Alpha particles have less penetrating force and can be stopped by thick paper or even a layer of clothing. They are also stopped by the outer layer of dead skin on people. This may seem to remove the threat from alpha molecules but only from external sources. In a case such as a nuclear explosion or some kind of nuclear accident where radioactive emissions are spread around the environment, emissions can be inhaled or taken with food or water and once the emitter is in you, you have no protection at all. Beta particles are much smaller than alpha particles and, therefore, have much less ionizing energy (less capable of damaging tissues), but their small size gives them much greater penetration power. Most resources say that beta particles can be stopped by a quarter-inch thick sheet of aluminum. Again, however, the greatest risk occurs when a beta source gets inside you. Gamma rays are not particles but a high energy form of electromagnetic radiation (such as X-rays except more powerful). Gamma rays are energy that has no mass or charge. Gamma rays have tremendous penetrating force and require several inches of dense material (such as lead) to protect them. Gamma rays may pass all the way through the human body without hitting anything. They are considered to have less ionizing power and the greatest penetration force. The safest amount of radiation to the human body is zero. It is not possible to be exposed to any ionized radiation so the next best goal is to be exposed to as little as possible. The two best ways to minimize exposure are to reduce exposure time and increase distance from the source. The The disintegration process that emits alpha particles is called alpha decay. An example of a nucleus that is subject to the decomposition of uranium-238 alpha. The decay of alpha \\)u=-238 is \\ce{{92}^{238}U} \rightarrow\ce{__2^4He} + \ce_{90}{234}Th\{alpha}}\=_u}}\\1=1\{238}\\3 This nuclear change, the uranium atom \ce{{92}^{238}U}\) turned into an atom of thorium \left \ce{_{90}^{234}ma) \right)) and in the process, gave off alpha particles. Look at the alpha particle code: \ce{_2^4and.\ Where does the Alpha particle get this code? The bottom number in the nuclear code is the number of protons. This means that alpha particles contain two protons that have been lost by the uranium atom. The two protons also charge \(+2\). The highest number, 4, is the number of mass or total protons and neutrons in a particle. Because it has two protons, and a total of 4 protons and neutrons, alpha particles must also have neutrons. Alpha particles always have the same composition: protons and neutrons. Another product of alpha particles is thorium-230. {{90}={230}={230}Th {226} {88}} Another common decay process is the emission of beta particles, or beta decay. Beta particles is just a high-energy electron emitted from the nucleus. It may occur that we are facing a logically difficult situation here. The cores do not contain electrons, however during beta decay, the electron is emitted from the nucleus. At the same time as the electron is ejected from the nucleus, the neutron becomes a proton. It is tempting to perceive this as a neutron breaking into two pieces with pieces that are protons and electrons. That would be convenient for simplicity, but unfortunately that's not what's happening; For convenience, though, we will treat beta decay as neutron splitting into protons and electrons. The proton remains in the nucleus, increasing the number of atomic atoms by one. The electron is ejected from the nucleus and is a radiation particle called beta. To enter an electron into a nuclear equation, and to have the number properly matched, the atomic number and the mass number had to be assigned to an electron. The mass number assigned to electron zero (0) which is reasonable since the mass number is the number of protonsamy nomad and newtononatated. The atomic number assigned to the electron is a so-called zero number (-1), because this allows the nuclear equation containing an electron to balance the atomic numbers. Therefore, the nuclear symbol that represents the electron (beta particle) is \\ce{_{_1}^0e}})) or \\ce{_{1}^0\beta} \label{beta1}\1=^0\beta} \label{beta1}\ce{_ It is a nucleus that is subject to beta decay. Here's the nuclear equation for this beta decay. {{90}^{234}Th} \yeintro\\{1}^0e} + \ce_{91}^{234}pa\label {beta2}}\Often, gamma ray production accompanies nuclear reactions of all kinds. In alpha decay,\ce{U}-238, gamma rays are emitted from various energies in addition to the alpha particle. {[\ce{_{92}^{238}U} \rightarrow\2{4He}+ \ce{{90}^{234}Th} + 2 \ce{_0\gamma}} Almost all nuclear reactions in this chapter also emit gamma rays, but simply do not show gamma rays in general. Nuclear reactions produce much more energy than chemical reactions. Chemical reactions release the difference between the chemical bond energy of the reactions and products, and the energies that are released have an order of size (1\times 10^3\text{kJ/mol}\\ Nuclear reactions release some binding energy and small amounts of the substance can be converted into energy. The energy that is released in a nuclear reaction has an order of size (1\10 times^{18}\\ \ This means that nuclear changes involve nearly a million times more energy per atom of chemical changes! Note almost all nuclear reactions in this chapter also emit gamma rays, but for simplicity gamma rays generally do not appear. The basic features of each reaction appear in Figure 17.3.2 Figure 17.3.2: Three most common patterns of nuclear decay when writing nuclear equations, and there are some general rules that will help you: the sum of the collective numbers (higher numbers) on the reactant side equals the sum of mass numbers on the product side. The atomic numbers (lower numbers) on both sides of the reaction will also be equal. In alpha decay of \x {238}U=)\\ref{alpha1})) both atomic numbers and mass: \238 = 4 + 234\) Atomic number: \92 = 2 +90\) make sure that this equation is properly balanced by adding up the reactive materials and the 'atomic' products and mass numbers. Also, note that since this is an alpha interaction of a product is an alpha particle, \\ce{_2^4is}.\\ Note that both mass numbers and atomic numbers correctly add to the beta decay of Thorium-234 (equation \\ref beta2}): Mass number: \234 = 0 + 234\) atomic number: \(90 = -1 + 91\) original nucleus mass numbers and new nuclei are the same because the neutron has been lost, but the refore the total protons plus neutrons is still the same. The atomic number in this process has increased by one since the new nucleus and one proton more than the original nucleus. In this beta decay, thorium-234 nucleus has one proton more than the original nucleus. In this beta decay, thorium-234 became the nucleus of proteactinium-234. Proactinium-234 is also a beta emitter and produces uranium-234. \rightarrow\ce{_{234} {92}_ Note: What about the administrator's budget? Both alpha-beta2 particles and most of the above nuclear reaction are shipped unbalanced with respect to charge, as discussed when balancing the oxidation reaction. When studying nuclear reactions in general, there is usually little information or concern about the chemical state of radioactive isotopes, because electrons from the electron cloud are not directly involved in nuclear reaction (in contrast to chemical reactions). So it's okay to ignore the charge of balancing nuclear reactions and focusing on balancing mass and atomic numbers only. The example of \pageIndex{1}\\ completes the next nuclear interaction by filling out the missing particles. {210} {86} The solution to this interaction is alpha decay. We can solve this problem in one of two ways: solution 1: when an atom gives off an alpha particle, its atomic number goes down by 2 and the number of its mass drops by 4 left: \\ce{{84}^{206}Po}). Solution 2: Remember that the collective numbers on each side should total up to the same amount. We are left with {84} the {206}Po={206})(2} example of the following nuclear reactions. b) Uranium-238 is degraded by alpha emissions. Solution a) Beta particles have the symbol \(\ce{_{-1}^0e}\0e\1\0e Emitted from a beta particle causes the atomic number to increase by 1 and does not change the overall number. We get the numbers and atomic symbols of the elements using our periodic table. We've left the following reaction: \ce{_{14}C} \\rightarrow\ce{__{14}_ The emission of an alpha particle reduces the atomic number by 2 and the collective number by 4. We've left with: \\{92}^{238}U} \rightarrow \ce{_2^4He} + \ce_{90}^{234}Th}] The decay of a radioactive nucleus is a step towards becoming stable. Often, the radioactive nucleus cannot reach a stable state through a single decomposition. In such cases, a series of decays occur until a stable nucleus is formed. The decay of \\ce{U}-238 is an example. The decomposition series (\ce{U})-238 begins with \\ce{U}-238 and travels through fourteen separate decompositions to finally reach a stable nucleus, \ce{Pb}-206 (Figure 17.3.3). There is a series of decays similar to \\ce{U}-235 and \\ce{Th}-232. \ce{U}-235 series ends with \\ce {Pb}-207 and \\ce{Th}-232 ends with \\ce{Pb}-208. Figure 17.3.3: Uranium-238 decomposition series. (CC-BY-3.0 Tosaka) many radioactive nuclei found in nature are present there because they are produced in one of the series of radioactive decay. For example, there may have been radon on earth at the time of its formation, but this original radon would have been decomposed by this time. The radon that exists now exists because it is formed in a decay chain (mostly by U-238). It is nuclear reaction that changes the structure of the nucleus of the atom. The atomic and mass numbers in the nuclear equation must be balanced. Protons and neutrons are made up of quarks. The two most common methods of natural radioactivity are alpha decay and beta decay. Most nuclear reactions emit energy in the form of gamma rays. This page of content across the following contributors (contributors) was created and edited (topically or widely) by libreTexts development team to meet platform style, presentation and quality: CK-12 by Sharon Buick, Richard Parsons, Tris Forsyth, Shona Robinson and Jean Duhardt. Pahad.