Chemistry radioactivity worksheet answers

Atomic theory of the tenth century presumed that nuclei was fixed compound. But in 1896, French scientist Henri Becquerel found that an uranium compound placed near a photographic plate made an image of the plate, though the compound was wrapped in black clothing. It was reason that the uranium compound had emitted some kind of radiation that passed through the garment to expose the photographic plate. Further investigations showed that the radiation was a combination of particles and electromagretic rays, with its ultimate source being the atomic nuclear. These lovingness was ultimately called, collectively, radioactivity. After the discovery somewhat serendipitous in radioactivity by Becquerel, many prominent scientists began to investigate this new, intrigued phenomenon. Among them was Marie Curie (the first woman to win a Nobel Prize, and the only person to win two nobel prize in different science-chemistry and physics), who was the first to coin the terms of radioactivity, and Ernest Rutherford (of Crazy Gold Experience), who is investigated with named three of the most common types of radiation. During the beginning of the twentieth century, many radioactive substances were discovered, the properties of radiation were investigated and calntified, and a strong understanding of radiation and nuclear career had developed. The spontaneous shift of an unstable linicid to another is radioactive career. The unstable nuclide is called the nuclide parent; the nuclusion that results from the decomposition recognized as the nuclide's daughter. Nuclide's daughter may be stable, or she can discover herself. The radiation produced during her radio-active career is like that the daughter lies near the band of stability than the niplicity parent, so where a nuclear relative of stability can serve as a guide for the decomposed type she will undergo (Figure 3.1). Figure 3.1 A nucleus of uranium-238 (nuclide to parents) underwent α calculated to form thorium-234 (daughter of nuclide). The alpha particle removed two protons (green) and two cleaning (gray) of the iryanium-238 nucleus. 3.1 Large Forms of Alpha Radioactivity Particles (α) Rutherford's experience demonstrate that there are three main forms of radioactive emissions. The first is called an alpha particle, which is symbolized by the Greek α. An alpha particle consists of two protons and two neutrons and is the same as a helium nuclear. (We often use 24He represents an alpha particle.) He had a charge of 2+. When an radioactive atom emits an alpha particle, the atomic atomic number decreases by two (because of the loss of two protons), and its mass numbers decrease by four (because of the loss of four nuclear particles). We can represent the emission of an alpha particle containing a chemical equation — for example, the emission of alpha-particles in uranium-235 is as follows: Rather than calling this equation a chemical equation, we call it a nuclear equation to highlight that changes in an atomic core. How do we know that a product of this reaction is 90231Th? We use this issue's conservation law, saying that this issue cannot be created or destroyed. This means we must have the same amount of protons and neutrons on both sides of the nuclear equation. If our uranium lost 2 protons, there are 90 protons remaining, identifying the component as the thoriom. Moreover, if we lose four nuclear particles to the original 235, there are 231 remaining. Thus, we use Subtraction to identify the isotop of the th atom – in this case, the 90231Th. Beta Particle (β) is the second type of radioactive emission called a beta particle, which is symbolized by the Greek β. A beta particle is an electron popped out of the nucleus (not from the steroids of electrons on the nuclear) and has a -1 charge. We can represent a beta particle as -10e. The net effect of beta particle emissions on a nuclear is that a neutron is converted into a proton. The overall mass number remains the same, but because the number of protons increases by one, the atomic number rises by one. Carbon-14 deputies do not emit a beta particle: Again, the sum of atomic numbers is the same on both sides of the equation, as is the sum of the mass numbers. (Note that the electron assigns an atomic number of -1, equal to its charge.) Gamma Radiation (γ) The third largest type of radioactive emission is not a particle but rather a very drastic form of electromagnitive radiation called gamma radiation, symbolized by the greek γ. Electromagremagical radiation can be characterized in different categories based on the length and energy photographn. Electromagmagical spectrum is shown in figure 3.2 shows the largest categories of electromagnial radiation. Note that the human sensory adaptations of eyes and audience have evolved to detect electromagnitive radiation, and radio waves containing waves between 1 mm and 100 kim and visible light have wavelengths between 380 – 700 nm. Technological advances have helped humans use other forms of electromagromagre radiation including X-ray radio and microwave. Figure 3.2 The Electromagmagretic Spectrum. A diagram of the electromagnerial spectrum, which shows various properties across the range of frequency and wavelenauts. Images available in Wikipedia some electromagnitive radiation and very short length are active enough that they can knock out electrons from atoms in a sample of gutters and make it electrical chargers. The types of radiation that can make these radiation temedse. X-ray radiation and gamma rays are examples of radiation isolation. Some radioactive materials, gamma radiation is emitted while decomposed. For example, in the decomposition of radioactive-99 techniques, a gamma ray is emitted. Note that in radioactive countdown where the issuance of gamma radiation occurs, that the identity of the parent material does not change, as no particles are physically emitted. Sometimes incomplete radioactive a sample result in the release of multiple forms of radioactivity. For example, in the decomposition of radio-222, Both alpha and gamma radiation are emitted, with the milk having an energy of 8.2× 10−14 J per nucleus discovery: This may not seem like much energy, but if 1 gelace of Rn atoms were decomposed, the gamma gamma energy would be 4.9 × 107 kJ! Alpha, beta, and gamma emissions have different ability to enter matters. The large alpha particle is easily stopped by matters (although it can share a significant amount of energy in the matter it contacts). Particle beta particles slightly in trouble, maybe a few centimeters at most. Gama's rays can join deeply into trouble and can share a large amount of energy in the enclosure issue. Table 3.1 summarizes the properties of the three main types of radioactive emissions and Figure 3.3 summarizes the capacity of each type of radioactive penetrated problem. Table 3.1 The three main forms of Radioactive Broadcast Figure 3.3 Illustrations in the relative capabilities of three different types of radiation join to penetrating solid problems. Typical alpha particles (α) are stopped by a sheet of paper, while beta particles (β) are stopped by an aluminum plate. Gama's radiation (γ) is replaced when she penetrating leads. Figures provided by Stannered Positron Emissions (β+ Peel) and Electron Capture in addition to the three largest types of radioactive particles listed above, two additional types less common in emissions have been discovered. These include positron broadcasts and captured electrons. Positron's broadcast (β+ decomposition) is to broadcast a positron from the nucleus. Oxygen-15 is an example of a nuclide that underwent positron emissions: emissions Positron observed for nuclides in which the US: carp ratio is low. These nuclides lie below the strips of stability. Positron Decompose is the conversion of a proton to a neutron and broadcasts a positron. N: The raising ratio, and the daughter lies near the strips of stability than the parent nuclide. Positron's having the mask of an electron, but a positive charge. So the overall mass of the nuclide does not change, but the atomic number is decreased by one, causing a change in the elementary identity of the daughter isotop. Electrons captured occur when one of the inner electrons in an atom captured by the atom's core. For example, potassium-40 underwent captured electrons: Electron capture occurs when a combined inner culmination with a proton and is converted into a cleaning. The loss of an electron cult electron leaves a vacation that will be filled by one of the outside electrons. As the electron drops outside of the vacation, it will emit energy. In most cases, the uniformed energy will be in the form of an X-ray radio. Like positron emissions, electron captured reach for proton-rich nuclei that sets below the strips of stability. Electronic capture has the same effect on the nuclear as do positron emissions: The atomic number is none and the mass number has not changed. This increases us :p ratio, and the daughter lies closer to lower strips of stability than the nuclear parent. Whether capturing electrons or positron emissions occurs is difficult to predict. The choice is mainly due to kinetic factors, and the one that required the smaller activation energy was one of the most likely to occur. Figure 3.4 summarizes these kinds of careers, along with the equation and changes in atomic and mass numbers. Figure 3.4. Summary of the type, nuclear equations, representations, and any changes to the masses or atomic numbers for various decomposed constituents. Occasionally, a nuclear atomic break is apart from smaller pieces of a radioactive process called spontaneous fission (or fision). Typically, the daughter isotopes produced by fission is a varying blend of products, rather than a specific isotopes as with alpha and emission particle beta. Often, fission produces excess neutrons that will sometimes be captured by other nuclei, perhaps produce additional radioactive events. Uranium-235 underwent spontaneous fission in a small state. A typical reaction is where 01n is a neutron. As with any nuclear process, the sum of atomic numbers and mass numbers must be the same on both sides of the equation. Spontaneous fision found only at great nuclei. The smaller nuclear that exposed spontaneous fission is lead-208. (Fission is the radioactive process used to plant naked power and a naked bomb type.) (Back in the top) 3.2 Half radioactive live each radioactive nuclide has a characteristic, constant half-life (t1/2), time needed for half of the atoms in a sample for decomposed. A half-lifetime allows us to determine how long a sample of a useful isotop will be available, and how long a sample of an undesirable or harmful isotope must be stored before it is discovered at a low-enough radiation level that is no longer a problem. For example, cobalt-60, an isotope that emits gamma rays used to treat cancer, has a half-life of 5.27 years (Figure 3.5). In a cobalt-60 source, since half of the decomposed nuclei every 5.27 years, both the amount of material and the intensity of the radiation is emitted to cut in half every 5.27 years. Note that for a given substance, the intensity of radiation that it produces is directly proportional to the rate of the substance and the amount of the substance. Thus, a cobalt-60 source used for cancer treatment must be replaced regularly to proceed effective. Figure 3.5. Decomposition Cobalt - 60. For cobalt-60, which has a half life of 5,27 years, 50% remain after 5.27 years (a half life), 25 remain after 10.54 years (two half lives), 12.5% remain after 15.81 years (three half-lives), and so on. Note that every half life is the same length of time. Since every half-life for an x-ray is the same length of time, we can use this equation to calculate how much radioactive nuclide will remain after lookup of any number(n) in half life: Question: Half the life of Zn-71 is 2.4 minutes. If one had 100.0g at the beginning, how many grams would have to stay after 7.2m minutes passed? Workaround: Step 1. Determine the number of half life spent: Number of half-lives = time spent divided by half-life (Make sure the time units match!!) Step 2. Use of the Isotop equation remains to settle for how much isotopes will remain after the number of half life determined in step 1 has passed. (Return of the Head) 3.3 Biological Effects of Radiation Exposure There is a big difference in the greatness of the biological effects of nonizing radiation (for example, lights and microwaves) with ional radiation, drastic emissions enough to knock electronics from molecules (for example, α and β particles, γ rails, X-ray, and high-energy ultraviolet radiation) (Figure 36.6). Figure 3.6. Damaging the ional radiation effect. Lower frequency, lower-energy electromagreic radiation is nonionizing, with higher frequency, higher-energy electromagromagical radiation is insulation. Energy absorbs from nonionizing radiation up the movement of atoms and molecules, which is equivalent to the sample's heating. Although biological systems are sensitive to heat (as we might know from handling a hot stove or spending a day at the beach in the sun), a large amount of nonizing radiation is needed before dangerous levels arrive in. Radiation izining, however, can cause much more severe damage by breaking links or removing electrons of biological molecules, disrupting the structures and functions (Figure 3.7). Figure 3.7. The biological effects of Ionize Radiation. Izing radiation can directly damage a biomolecule by exciting it or breaking its link radiation can harm either the whole body (somatic damage) or eggs and eggs (genetic damage). Its effects are most pronuncing in cells that reproduce rapidly, such as stomach lines, hair follicularity, bone range, and embryonic. That's why patients undergo radiation therapy often feel full or sick in their stomach, hair loss, have pain bones, and so on, and why particular care must be taken when they undergo radiation therapy during pregnancy. (Return to the top) 3.4 Use of Isotopes Radioactive Isotopes radioactive isotopes have the same chemical properties as isotopes stable of the same element, but they emit radiation, which can be detected. If we replace one (or more) atom(s) with radiozip(s) in a compound, we can follow them by controlling the radioactive emissions. This is the type of compound called a radioactive tracer (or radioactive label). Radioisotopes are used to track the paths of biochemical reactions or to determine how a substance is distributed to an organism. Radioactive tracers are also used in many medical applications, including both diagnosis and treatment. They are also used in many other industries to measure wearing engines, analyzing the geologic training around oil assets, and More. Radioisotopes have revolutionary medical practice, where they are used extensively. Over 10 million nuclear medicine procedures and more than 100 million nuclear tests are conducted annually in the United States. Four typical examples of radioactive plot are used in the technical-99 medicines, toilet-201, iodine-131, and sodium-24. The damaged tissue of the heart, liver, and lungs absorb certain technical compounds — 99% preferently. After it is shot, the location of the technical compound, and like what was damaged the tissue, can be determined by detecting the rays γ emitted by the Tc-99 isotopes. Thallium-201 (Figure 3.8) becomes the focus of tissue that health, so the two isotopes, Tc-99 and Tl-201, are used together in studying heart tissue. Iodine-131 focuses in the thyroid gland, the liver, and some parts of the brain. It can therefore be used to control goiter and treat thyroid conditions, such as the severe diseases, as well as liver and brain tumors. Single solution contained consist of sodium-24 to inject into the blood to help obtain blockade of the flow of blood. Figure 3.8. Administering thallium-201 to a patient and subsequently performing a stress test offers medical professionals an opportunity to visually analyze heart function and blood flow. (credit: Modification of Works by Blue0ctane/Wikimedia Commons) Radioisotopes are used in medications typically have short half-life — for example, Tc-99 has a 6.01-life span of 6.01 hours. This makes Tc-99 essentially impossible to store and ban pulpit from transportation, so it is made on-site instead. Hospitals and other medical facilities use Mo-99 (which are mainly extracted from U-235 fision products) generate tc-99. Mo-99 underwent β decomposed with a half-life of 66 hours, and the Tc-99 is then chemical extracted (Figure 3.9). The parent nuclide Mo-99 is part of a mobdere ion, ; when he careers, he forms the ion of pertechnetate, . These two water-solib ions are separated by column chromatography, with the higher load mobilizing adsorbing on the aluminum in the column, and lower load petechnet ion than in the column of the solution. A few micrograms of mo-99 can produce enough Tc-99 to make as many 10,000 tests. Figure 3.9. (a) the first Tc-99m generator (1958 cycle) is used for separating Tc-99 from Mo-99. The MoO42 - is retained by the matrix in the column, whereas TcO4-. pass through and it collects. (B) Tc-99 was used in this scan in the neck of a patient with severe disease there. The scan shows the location of high concentrations of Tc-99. (credit a: modification of work by the Department of Energy; credit b: modification of work by MBq/Wikimedia Commons) Positron Emissions Tomography (PET) scans using the dying radiation and track health condition and monitored medical treatment by revealing how part of a patient's body function (Figure 3.10). To scan PET, a positron-emetting radioisoistop produces abortion. psychlotrons and then attached to a substance used by parts of the body being investigated. This tagged compound, or radiotracer, is then administered to the patient (injected via IV or breathing in as a gas), and how it is used by the tissue to reveal how organs or other areas of the body functions. Figure 3.10. A PET scanner(A) uses radiation to provide an image of how part of a patient's body functions. The scans it produces can be used in images of a healthy brain (b) or can be used to diagnose medical conditions such as Alzheimer's disease (c). (credit A: Modification of Works by Jens Maus) For example, the F-18 is produced by proton bombardment of 18O() and incorporating into a glucose analog called fludeoxyglucose (FDG). How FDG is used by the body to provide critical diagnostic information; for example, since cancer is used to glucose a different way than normal tissue, FDG can reveal cancer. The 18F emits positrons that communicate with nearby electrons, producing a burst of gamma radiation. This energy is detected by the scanner and converts to a detailed, three-dimensional, color image that shows how this part of a patient's body functions. Different levels of gamma radiation produce different amounts of brightness and color in the image, which can then be interpreted by a radiology revealing what is going on. PET scans can detect heart damage and heart disease, helping diagnose Alzheimer's disease, indicate part of a brain affected by epilepsy, cancer reveals, shows what stage it is , and how much it has spread, and whether treatments are effective. Unlike reasoning magnetic images and X-ray, which only shows how something looks, the huge asset of loss scans is that they show how something functions. PET scans are now usually performed in concordance with a computer tomography scan. Radioisotopes can also be used, typically at higher doses than as a tracer, as treatment. Radiation therapy is the use of high-energy radiation to damage the BDS in cancer cells, which kill or keep them in divide (Figure 3.11). A cancer patient can receive external radiation therapy delivered by a car outside the body, or internal radiation therapy (brachytherapy) from a radioactive substance introduced into the body. Note that chemotherapy is similar to internal radiation therapy in that the cancer treatment is injected into the body, but differs from which chemotherapy uses chemical rather than radioactive substances to kill cancer cells. Figure 3.11. The design of (A) shows a cobalt-60 machine used in cancer treatment. The diagram of (b) shows how the gantry of the Co-60 machine swung to an arc, focused radiation on the targeted region (tumor) and minimized the amount of radiation spent in nearby regions. Cobalt-60 is a synthetic radiozyotop produced by the neutron's activation of Co-59, which then underwent β to form Ni-60, along with the issuance of γ radiation. Overall is: The scheme in general for this to display graphically in Figure 3.12. Figure 3.12. The Co-60 underwent a series of radioactive corpses. Radiation γ used for radiation therapy. Radioisotopes are used in various ways to study the mechanisms of chemical reactions in plants and animals. These include fertilizers label nutrient sciences attacked by plants and crop growth, scrutiny of digestive and milk-producing processes in grabs, and science on the growth and metabolism of animals and plants. For example, the X-14 used helicopter details on how fotosynthesis occurs. The overall reaction is: but the process is much more complex, proceedings across a series of steps in which various organic compounds are produced. In studies on this reaction route, plants were exposed to CO2 that have a high concentration of. At regular intervals, plants were analyzed to determine which organic compounds contained carbon-14 and how many of each compound were present. From the time sequence to which the compound is displayed with the number of each present at given time intervals, scientists have learned more about the way of the reaction. Commercial applications of radioactive materials are equally diverse (Figure 3.13). They include determining the thickness of films with thin metal sheets by exploiting the power of retraction of various radiation. Flaws in metals used for structural purposes can be detected using high-energy gamma rays from cobalt-60 in a mode similar to the way X-rays are used to examine the human body. In a form of pest control, flies are controlled by sterilized handrail males and γ radiation so that women are elevated with them by producing offspring. Many meals are maintained by radiation that kills microorganisms that cause their food to ruin. Figure 3.13. Common use of commercial radiation includes (A) X-ray examination of luggage at an airport and (b) preservation of food. (credit a: modification of work by the Army Department; credit b: modification of works by the U.S. Department of Agriculture) U.S.-241, a α emitted with a half life of 458 years, is used to tiny amounts of detected smoke excision-types (Figure 3.14). The α from Am-241 ionize the air between two electrode patches in the room that are ionized. A battery provision for a potential causes movement of the ions, thus creating a small electric current. When smoke enters the chamber, the movement of ions is prevented, reducing conductivity in the air. This causes a marked drop in the current, triggering an alarm. Figure 3.14. Inside a smoke detector, Am-241 α ionize the air, creating a small electric current. During a fire, particles of smoke prevent flow of ions, decrease the actual and trigger an alarm. (credit a: modification of work by Muffet/Wikimedia Commons) (Back to the top) Radioactivity defined as particle emissions and electromagnetic rays of of an unstable atom. Six types of radiation produced during the two nuclear protons were presented in this chapter and include: alpha (α) which is composed of two protons and two neutrons and has a +2 charge. beta (β) which is an electron filed from the core (not of the electron ships on the nuclear) and has a -1 charge and no mass. At the core a neutron emits electrons in and is converted into a proston in the process. Gamma (γ) is characterized by the issuance of radiation issuance and does not contain mask or charge. positron (β+) emissions which is a swimming positron from the core and has a +1 charge and no mask. At the core a proton emits the positron and is converted into a neutron in the process. electron capture occurs when an electron interior binary is combined with a proton and is converted into a neutron. The loss of an electron cult electron leaves a vacation that will be filled by one of the outside electrons. As the electron drops outside of the vacation, it will emit frequent energy in the form of X-ray. nuclear fission occurs when a nuclear atomic break is apart from smaller pieces of a radioactive process that releases excess neutrons. Each radioactive nuclide has a characteristic, constant half-life (t1/2), time needed for half of the atoms in a sample so they can die. The following equation can be used to determine how much isotopes will remain after the passage of a half-life radioactive emissions can cause damage to biological systems by causing protein outage and GNA. This can lead to cellular and genetic damage and increase a person's risk for diseases such as cancer. However, when use is small amounts and in controlled environments, radioactive tracing and treatments have proven to be revolutionary for the medical field. For example, radiation therapy is the use of high-energy radiation to damage the cancer cells, which kills them or keeps them from dividing. radioactive traces were also very useful in evaluating heart disease, thyroid diseases, thyroid dysfunction, and other blood disorders. Positron's emission tomography (PET) analysis uses radiation to diagnose and track health conditions and monitored medical treatments by revealing how parts of a patient's body function and X-ray were used to visualize the bone break and capitulation of teeth. (Return to the top) 3.6 References unless otherwise noted, resources for this chapter have been modified in the following creative resources: resources: