**Nuclear Chemistry Notes**

|  |  |
| --- | --- |
| **Regular Chemistry** | **Nuclear Chemistry** |
| * involve changes in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | * result from changes within the \_\_\_\_\_\_\_\_\_\_\_\_ |
| * absorb and release \_\_\_\_\_\_\_\_\_\_\_\_\_ amounts of energy | * absorb and release \_\_\_\_\_\_\_\_\_\_\_\_\_ amounts of energy |
| * reaction rates \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ by temperature, pressure, concentration, & catalysts | * reaction rates \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ by temperature, pressure, concentration, & catalysts |

**Label the following nuclear symbol**

**Nuclear Equations**

* Nuclear equations **must** be balanced with respect to
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) **AND**
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
* Ex)

The reactants are an N-14 nucleus and a neutron.

The products are a C-14 nucleus and a H-1 nucleus.

* The atomic numbers add to \_\_\_\_\_\_\_\_ on both sides.
* The mass numbers add to \_\_\_\_\_\_\_\_\_\_ on both sides.

**Radioactivity**

* A radioactive nucleus spontaneously decomposes (“decays”) with the evolution of \_\_\_\_\_\_\_\_\_\_\_\_.
* In doing so, radioactive decay actually \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ one chemical element to another element.

**Modes of Decay**

* Naturally occurring radioactive nuclei commonly decompose by
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_particle emission (α)
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_particle emission (β)
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ radiation emission (γ)

**Alpha Particle Emission**

* An alpha particle is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ charged nucleus.
* If an unstable nucleus emits an alpha particle, its atomic number \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and its atomic mass \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Ex) The decay of thorium-232

thorium-232 radium-228 alpha particle

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ elements, such as uranium and thorium, tend to undergo alpha emission.

**Beta Particle Emission**

* A beta particle is an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The symbol used in nuclear equations is
* In beta particle emission, electrons are emitted from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, NOT from surrounding electronic \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* The beta particles are created from the decay of a neutron to a proton.

* The creation of the proton causes the atomic number to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Ex) The decay of lead-212.
* The atomic number \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ due to the new proton.
* The atomic mass \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in beta particle emission.
* Isotopes with a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ neutron/proton ratio often undergo beta emission.
* this decay mode allows the number of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to be decreased by one

**and**

* the number of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to be increased by one
* thus \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the neutron/proton ratio.

**Gamma Radiation Emission**

There is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ associated with gamma emission.

* Gamma radiation emission is similar to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – high energy, short wavelength radiation.
* Gamma radiation commonly accompanies both alpha and beta emission, but it’s usually \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a balanced nuclear reaction.
* Some isotopes, such as Cobalt-60 (Co-60), give off \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of gamma radiation.
* Co-60 is used in the radiation treatment of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* The medical personnel focus \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on the tumor, thus destroying it.

**Summary of Radioactive Particles**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Radiation** | **Symbol** | | **Particles/Waves** | **Electric Charge** | **Energy** | **Energy stopped by** |
| Alpha particle | α |  | 2 protons, 2 neutrons | positive | Low | A piece of paper |
| Beta particle | β |  | 1 electron | negative | Medium | Lead 1 cm thick |
| Gamma radiation | γ |  | wave of energy | no charge | high | Thick lead or concrete |

**Radioactive Decay**

* Decay happens in a particular order, over a particular period of time.
* The amount of time it takes for \_\_\_\_\_\_\_ of the atoms of a radioactive sample to decay is called the **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**of the isotope.
* Ex) Radium-226 has a half-life of 1,602 years. If a 10g sample of 226Ra is placed in a weighing dish and left in a locked vault, how much will be in the weighing dish after 1,602 years? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Fission Reactions**

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ atoms
* During a fission reaction a large isotope is bombarded with a second smaller one (commonly a neutron).
* This causes the larger isotope to break apart into two or more elements.
* Ex)
* These reactions release a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of energy.
* Where does the energy come from?
  + When you make VERY accurate measurement of the masses of all the atoms and subatomic particles you start with and all the atoms and subatomic particles you end up with, and then compare the two, you find there’s some “missing” mass.
  + Matter disappears during the nuclear reaction.
  + This loss of matter is called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + The missing matter is converted to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* You can calculate the amount of energy produce during a nuclear reaction using the equation E=mc2

*( E is the amount of energy produced, m is the “missing” mass, c is the speed of light )*

* The speed of light is squared, making that part of the equation a very large number that, even when multiplied by a small amount of mass, yields a LARGE amount of energy.
* The atomic bombs dropped on Hiroshima, Japan on August 6, 1945 and on Nagasaki, Japan on August 9, 1945 were both \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_reactions.
  + In an atomic bomb, two pieces of a fissionable isotope are kept \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ until it’s time for the bomb to explode.
  + Conventional explosive force the two pieces together to cause a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + Once you have reached critical mass, the chain reaction is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, releasing a tremendous amount of energy almost instantly.

**Fusion Reactions**

* Essentially the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of a fission reaction.
* A process by which lighter nuclei are fused into a heavier nucleus. This is the process that powers the \_\_\_\_\_\_\_\_.
* In a series of nuclear reactions, 4 isotopes of H-1 are fused into a He-4 with the release of a tremendous amount of energy.
* Hydrogen bombs – are a fusion reaction
  + They are approximately \_\_\_\_\_\_\_\_\_\_\_ times as powerful as an ordinary atomic bomb.
  + The isotopes of hydrogen needed for the hydrogen bomb fusion reaction were placed around an ordinary fission bomb.
  + The explosion of the fission bomb released the energy needed to provide the activation energy (the energy needed to start the reaction) for the fusion process.