Nuclear Physics

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1 Particles and their properties

1.1 The atomic mass unit

The atomic mass unit (also AMU) is defined as $1.6605390710^{-27}\ Kg$. It has the unit u. It was defined such that the mass of a proton (and a neutron, which has the same mass) is $1u$.

1.2 The electron

The electron is an *elementary particle*, which is a particle that has no building blocks, but is itself among the smallest possible building blocks. The mass of an electron is $0.000548579909\ u$, and it has a charge of $1.60217663 \times 10^{-19}\ C$, which is equal to the elementary charge e.

1.3 The proton

The proton is a *non-elementary* particle, which consists of *quarks* which are elementary particles. It has a mass of $1\ u$, and is positively charged by $+1\ e$.

1.4 The neutron

The neutron is, as it's name implies, neutrally charged, meaning it has a charge of 0, it does however have the same mass as a *proton*, i.e. $1\ u$.

1.5 The positron

The *positron* is something which may also be encountered, and can easily be confused with the proton. It is significant to note that the positron is an *elementary particle*, and is the anti-matter form of the *electron*, so it has the same mass ($0.000548579909\ u$), and a charge of $+1\ e$.

2 Types of radiation

2.1 α-radiation

Alpha Radiation or *Alpha Decay* is when a particle releases another particle, a so-called α-*particle* as it decays.

$$ {}^{A}_{Z}X \rightarrow \ {}^{A-4}_{Z-2}X' + \ {}^{4}_{2}\alpha $$

What *is* an α-particle?

An alpha-particle looks exactly like a He-nucleus, that is, two protons & 2 neutrons. Ignoring the amount of electrons, following is true:

$$ {}^{4}_{2}\alpha \ = \ {}^{4}_{2}He $$

2.2 β-radiation

Beta Radiation or *Beta Decay* is when a particle releases an electron and a neutrino as it decays, by a neutron splitting into an electron and a proton.

$$ {}^{A}_{Z}X \rightarrow \ {}^{A}_{Z+1}X' \ + \ {}^{0}_{-1}e \ + \ \bar{v} $$

Sidenote:

Since elements release electrons as they decay, and gain a proton, the element itself changes to the next element over in the periodic table.

2.3 γ-radiation

3 Nuclear Reactions

3.1 Transmutation

It is possible to transmute one particle into the other by fusion. For example:

$$^{14}_{7}N \ + \ ^{4}_{2}He \ \rightarrow \ \ ^{17}_{8}O \ + \ ^{1}_{1}H$$

3.2 Energy released

In nuclear reactions, there is often a *mass deficit* (Δm), which is then related to a certain energy which that mass converts into, ΔE. Said energy is provided by Albert Einstein's famos equation:

$$E = mc^2$$

Which can be translated into:

$$\Delta E = \Delta mc^2$$

Example: