

# Radioactivity 05/11/2022

Saturday, 5 November 2022 14:45

GCSE...

What is radioactivity?

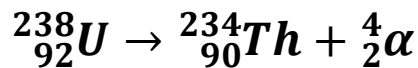
**Unstable nuclei decaying into more stable atoms.**

What are the forms of radioactivity?

- **Alpha  $\alpha$ :  $2p2n^{2+}$ , stopped by paper, most ionising**
- **Beta  $\beta$ : high-speed electron,  $e^-$ , stopped by aluminium, middle-most ionising**
- **Gamma  $\gamma$ : E.M. wave, stopped by lead and concrete, least ionising**

What is half-life?

**Amount of time it takes for the half of the total number of radioactive nuclei to decay to their daughter nuclides**



How can we express half-life?

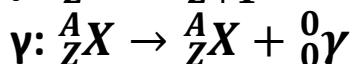
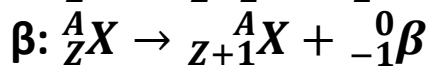
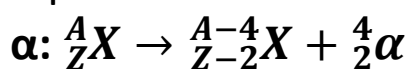
$$\frac{1}{2^n} \times n$$

$$\frac{1}{2^5} \times n = \frac{1}{32} \times n$$

$\Leftrightarrow$

$$\log_2(32) = 5$$

Equations:



Beyond GCSE...

$\gamma$  - Why?

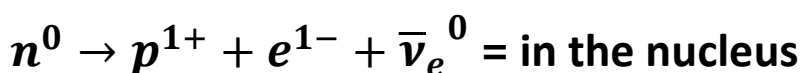
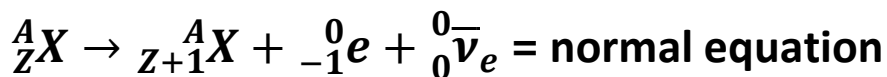
**Gamma radiation occurs after alpha or beta decay because the atom has excess energy after the decay that must be expelled to return to a ground state.**

**Isomer = Atom with excess energy, this means it's in an excited state and needs to return to the ground state.**

$\beta$  - Why?

**Beta radiation changes the atomic number of an atom due to an underlying physical process. This process is the reason why beta decay actually occurs and is measurable.**

**In the nucleus of an unstable atom, a neutron changes to a proton, electron and electron antineutrino.**



**This change means that the mass number remains unchanged and the atomic number increases by one.**

Radioactivity - Why?

**Nuclear binding energy = force that holds the nucleus together.**

**Two forces act upon the nucleus= nuclear binding energy (strong nuclear force) + electromagnetism**

**Strong nuclear force = holds the nucleus together**

**Electromagnetism = breaks the nucleus apart**

**If the strong nuclear force is stronger or weaker than electromagnetism then the nucleus falls apart.**

**Other decay modes:**

- **Proton (p + 2p) = a proton rich nucleus spits out a proton**
- **Neutron (n + 2n) = a neutron rich nucleus spits out a neutron**
- **Beta-plus ( $\beta^+$ ) = proton decays to a neutron, releasing a positron and an electron neutrino**
- **Electron Capture (EC,  $\epsilon + \epsilon\epsilon$ ) = A deficit of electrons is made up for as the atom captures a neighbouring electron**
- **Spontaneous Fission (SF) = nucleus is too large so splits into two**
- **Cluster Decay (CD) = a large nucleus emits a particle larger than an alpha-particle**

**Calculating mass number of stable nuclides:**

**For early nuclides the neutron number is almost equal to the atomic number. However, for later nuclides there are many more neutrons to protons.**