Changes in the Nucleus

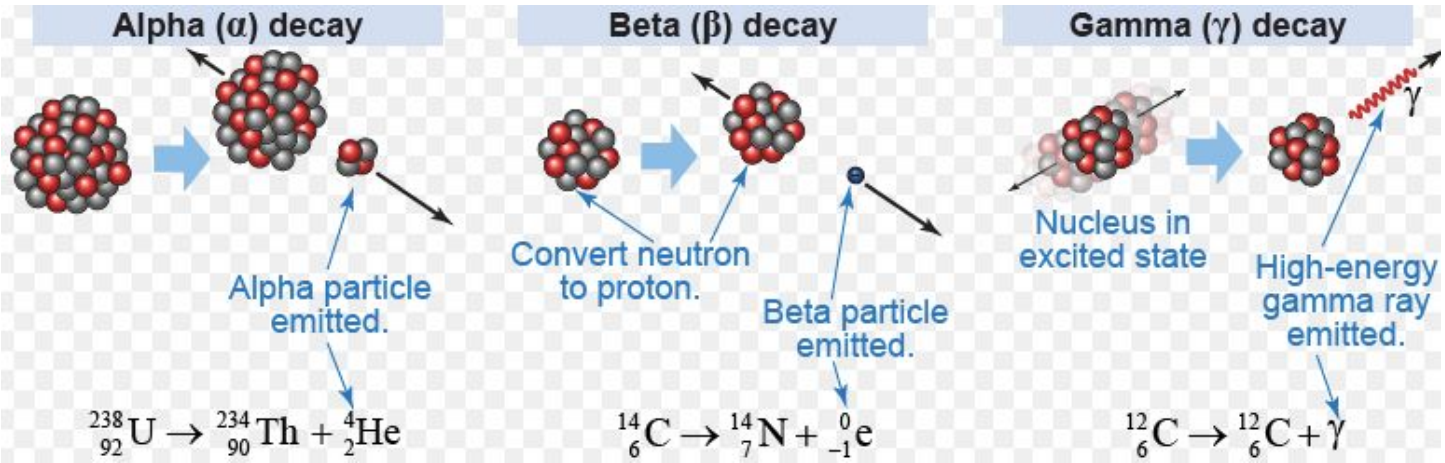
Sister Encarnación: Where are your robes, Ignacio?

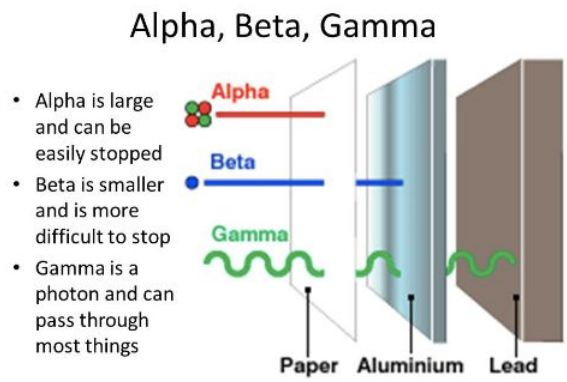
Nacho: They were... stinky. These are my recreational clothes.

Sister Encarnación: They look expensive.

Nacho: Thank you. I mean... they might have the appearance of riches, but beneath the clothes, we find a man... and beneath the man we find... his... nucleus.

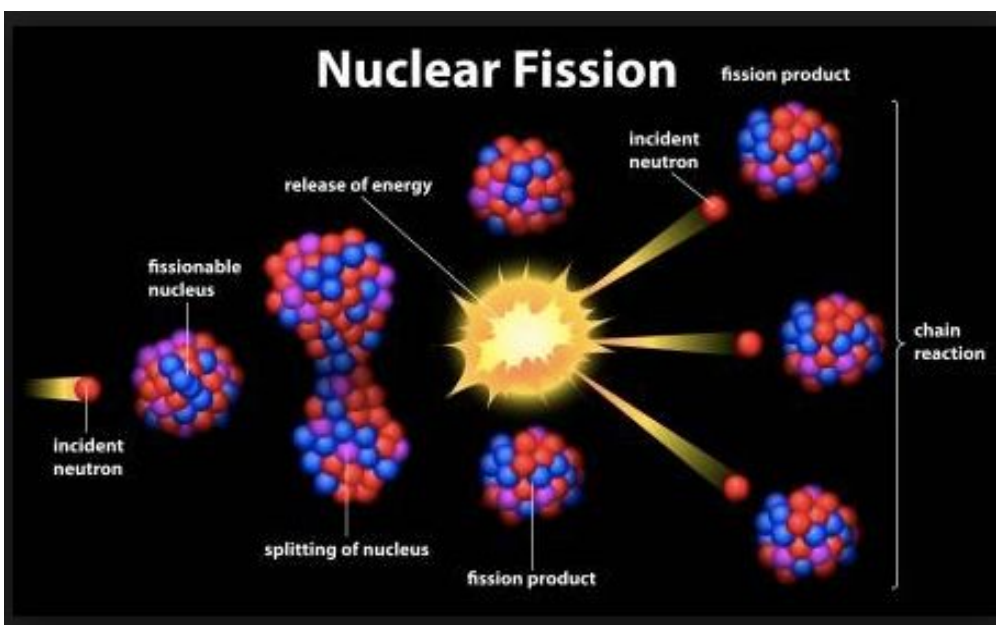
- Nuclear radiation: energy given off when an atomic nucleus breaks up or undergoes a change
  Radioactive: any substance that is unstable and likely to produce radiation
- Radioactive decay: process by which atoms of one substance change into atoms of another substance; occurs when nucleus breaks up or changes, emitting radiation
  Ex: radium-226 → radon-222
- Half-life: length of time required for one half of the original substance to decay into a new substance
- Alpha (α) decay: unstable atom ejects a clump of two protons + two neutrons called an alpha particle → new atom has an atomic # two less and a mass # four less; can be stopped by a sheet of thick paper
- Beta (β) decay: neutron in nucleus changes into a proton, emitting an electron → atomic number increased by one; can be stopped by aluminum foil or wood
- Gamma (γ) decay: excited nucleus releases energy without a change in number of protons or neutrons; energy released as gamma radiation (high frequency and energy); can penetrate 2-3 ft of concrete
- In large enough amounts, all three major forms of nuclear radiation can harm living things by disrupting the chemical processes within cells
- Nuclear radiation benefits: nuclear medicine, food irradiation





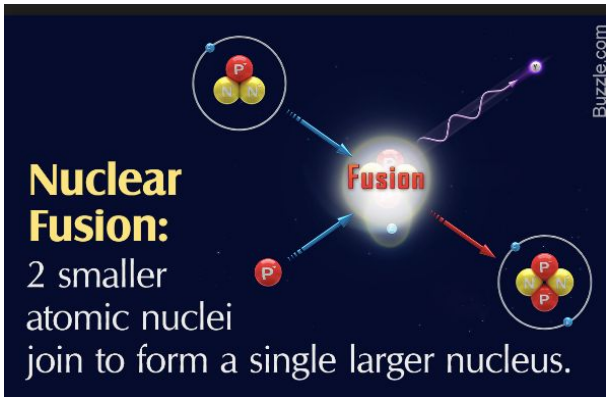
Nuclear Fission

- Division of a heavy nucleus by bombarding it with neutrons, causing the nucleus to rapidly vibrate and split → releasing an enormous amount of energy; U-235 (uranium-235)
- Chain reaction: other atoms capture free neutrons from a split atom, causing them to undergo nuclear fission as well; critical mass is minimum amount of mass required for chain reaction
- Atomic bomb: uncontrolled chain reaction in which pure U-235 can split trillions and trillions of atoms in only millionths of a second, releasing a tremendous amount of energy in an enormous explosion; temperature of fragments may reach 180.000.000℉ causing them to shine far brighter than the sun
- Nuclear reactor harnesses energy from a controlled chain reaction; use heat given off by nuclear fission to produce steam



Nuclear Fusion

- Process of combining two nuclei to form a heavier nucleus and releasing energy
  Ex: forcing together nuclei of two H atoms (1 proton each) forms a nucleus of He (2 protons) and release energy
- Requires extremely high temps (180,000,000°F) and pressure
- Scientists believe sun is powered by nuclear fusion
- Hydrogen bomb (H-bomb) uses nuclear fusion to release tremendous amounts of energy
- Fusion is a much harder reaction to achieve, however it yields more energy than fission. There is no chain reaction involved – hence there can not be an explosion – the reaction is achieved simply by getting the fuel hot enough and containing it tightly enough for the components to collide and fuse.



Electrons and Chemical Properties

- Valence shell: outermost shell of an e-
  Valence e-: e- in the valence shell; number of valence e- determines many of an element's properties
- Octet rule: most elements react to obtain eight e- in valence shell (except H and He which desire two valence e-)

Periodic Table

- Periodic law: when elements are arranged by their increasing atomic numbers, they show regular and repeating (periodic) properties
- Periodic table of elements (Mendeleev): table of elements arranged by atomic number and number of valence e-
- Period: row of elements; arranged in increasing atomic number (#protons) from left → right
  Elements in same period have same number of e- shells

- Group: column of elements; atoms with same number valence e- are in same group; divide elements based on chemical and physical properties
  Each group assigned a Roman numeral
- Main-group elements in groups 1,2,13-18 are involved in most common chemical reactions
  For main-group elements, number of valence electrons = digit in the ones place
- Metals: hard, dense, shiny solids that are good conductors of heat and electricity and have high melting points (Hg is a metal that is liquid at room temp)
- Nonmetals: poor conductors of electricity and heat
- semimetals/metalloids: solids that have properties intermediate between metals and nonmetals
- Group 1: alkali metals; very soft, shiny metals with low melting points (H not a metal);
  valence e- = 1 so combine easily with other atoms
  Ex: Na, K
- Group 2: alkaline earth metals; harder and denser than alklali metals
  Valence e- = 2
  Ex: Mg, Ca
- Groups 3-12: transition metals
  Valence e- = 1 or 2
  Ex: Fe, Cu, Au, Cr
- Inner transition metals fit between groups 3-4
  Valence e- = 2
  Ex: Am, Pu, U are radioactive
- Groups 13, 14, 16a: mixed groups
  Composed of nonmetals, semimetals, and metal
  Ex: O, N, C (various forms), Al, Sn, Pb
- Group 17: halogens; "salt formers" because they easily combine with alkali and alkaline earth metals to form salts (NaCl)
  Ex: Fl, Cl, Br, I
- Group 18: noble gases; rarely combine with other elements; all found in nature in pure states
  Valence e- = 8
  Ex: Ar, Kr (not kryptonite), He, Ne