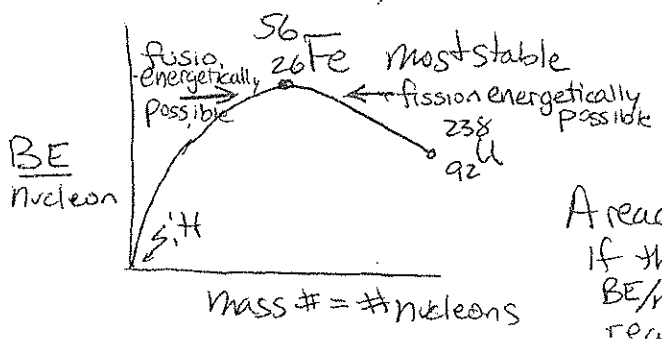


①

Stability of a nucleus is related to binding energy/nucleon.

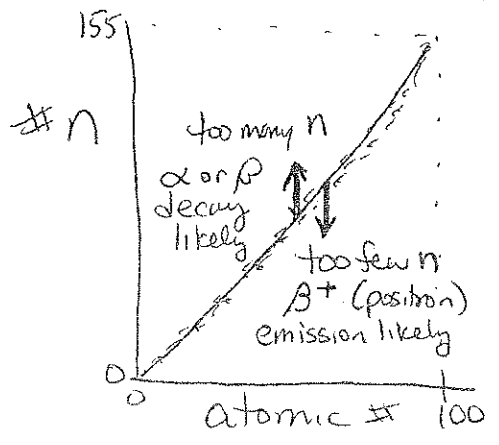
more $\frac{BE}{\text{nucleon}}$ = more stable nucleus



see St.G. p64

A reaction is energetically possible if the products have a larger BE/nucleon compared to the reactants.

Also for stability



see St.G. p 60

Small atoms $\#n \approx \#p$
large atoms $\#n > \#p$

Isotopes - Atoms of the same element (same $\#P$) but different mass # (different $\#n$)

example hydrogen

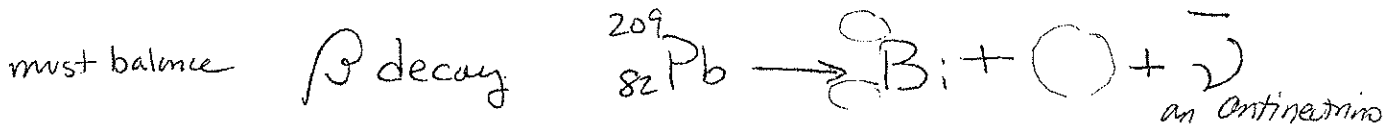
- protium 1P
- deuterium 1P + 1n
- tritium 1P + 2n

2

Natural Radioactivity - spontaneous emission of rays by an element (α, β or γ)

1. every element has at least 1 radioactive isotope
2. above atomic # 83 all isotopes are naturally radioactive

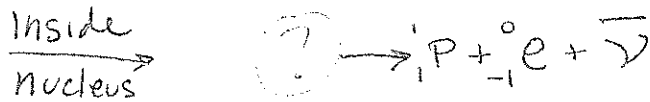
Natural Transmutation - The process whereby a nucleus changes into the nucleus of a different element. # of must change



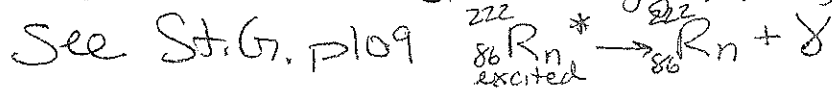
Also called β^-
Beta MINUS

note - β is a high speed electron (matter) it is always emitted along with the antineutrino (anti-matter)
 opposite \nearrow

In β decay #P increases by 1 but mass # does not change. How is this possible?



Gamma emission - Not transmutation - No new product - This occurs after another nuclear reaction the nucleus is in an excited state - The gamma is emitted (Energy released) as the nucleus goes to a more stable state (lower Energy level)



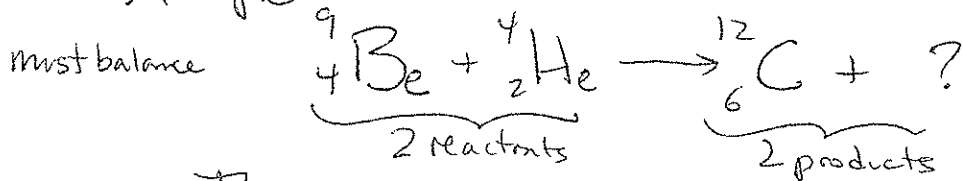
Do WS P19
 bottom 1-7 odd

2

(3)

Artificial Transmutation - bombard a nucleus with a particle (α, β, n, p) to change it into a different element. All must be high speed particles except n . Why?

Example In 1932 Chadwick



This reaction type always has 2 reactants, 2 products

Artificial Radioactivity - stable elements made into radioactive isotopes - Radioactive isotopes of all elements can be made this way.

Artificially radioactive isotopes can emit α, β, γ or β^+

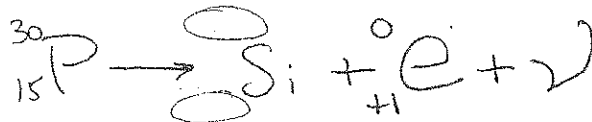
also written as ${}^0_+e$ this is a Positron

A positron is an antielectron (antimatter)

${}^0_{-1}e$ matter ${}^0_{+1}e$ antimatter. Same mass
 Opposite sign.

must balance

Positron emission



Also called Beta Plus

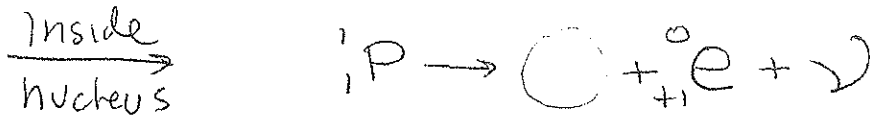
$${}^0_{+1}e = {}^0_{+1}\beta$$

Positron + neutrino
 antimatter, matter
 opposite

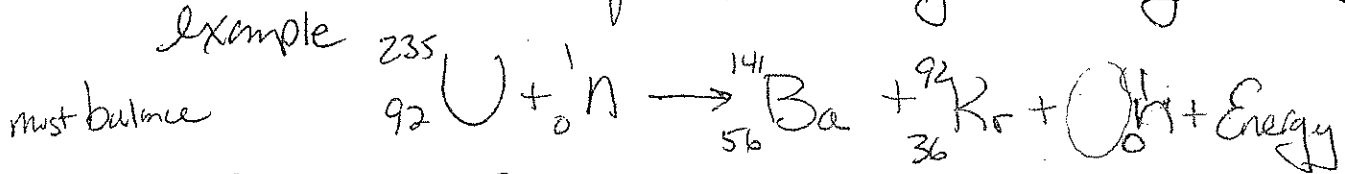
(3)

(4)

in β^+ decay # P decreases by 1 but mass # does not change. How is this possible?



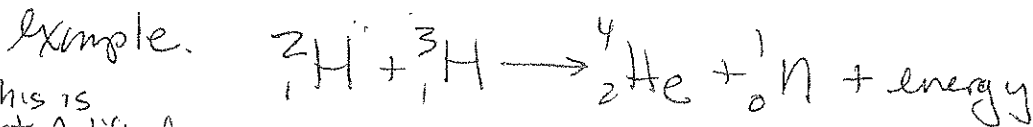
Nuclear Fission - some heavy nuclei can split into 2 almost equal parts by absorbing neutrons



see St.G. p64. Chain reaction neutrons are both a reactant and a product. More are produced

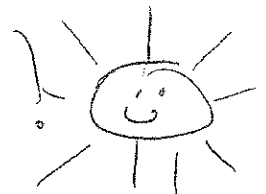
In a nuclear plant - fission reaction is controlled
In a nuclear bomb - fission reaction is NOT controlled.

Nuclear Fusion - combining 2 lighter nuclei to produce a "heavier" nucleus



Note - This is Not Artificial Transmutation

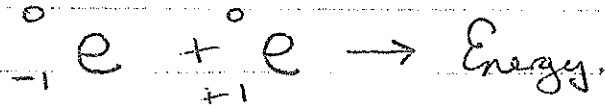
This occurs naturally on the sun



(5)

⑤ Annihilation -

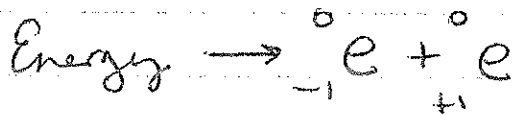
Matter and its antimatter pair come together and all the matter is converted to energy.



What is the total amount of energy produced when an electron and positron annihilate each other?

Pair Production

Energy is transformed into a matter/antimatter pair



How much energy is needed to produce an electron and antielectron?