$_{Z}^{A}X$

Z: atomic number = # of protons

A: mass number = N + Z

N: neutrons

neutrons → 5, 6, 7, 8

$_{6}^{11}C$ $_{6}^{12}C$ $_{6}^{13}C$ $_{6}^{14}C$ ⟹ Isotopes

---

electron	proton	neutron
-ve	+ve	no charge
-1.6×10^{-19}	$+1.6\times10^{-19}$	—
9.11×10^{-31}	1.67×10^{-27}	1.67×10^{-27}

positron: +ve 1.6×10^{-19} 9.11×10^{-31}

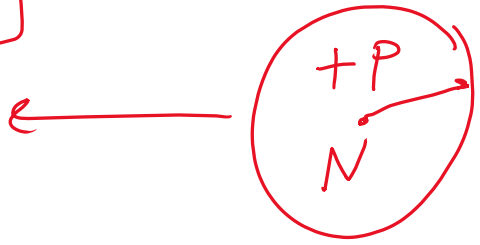
atomic mass unit (u) = 1.66×10^{-27} kg

nuclear force: 10^{-15} m

p-p

n-n

p-n



$r = a A^{1/3}$

A: mass number

$a = 1.2\times10^{-15}$

atoms are stable / unstable

$Z \leq 20 \Rightarrow$ stability $\underline{Z = N}$

$Z > 20 \Rightarrow$ stability $N > Z$

$Z > 83 \Rightarrow$ no stable atom.

Binding Energy:

$$E = mc^2$$

$$E_b = \left[Z\, M(H) + N\, m_n - M\left({}^{A}_{Z}X\right) \right] \times 931 \text{ MeV}/c^2$$

- Z: atomic number
- N: # of neutrons
- m_n: mass of neutron
- $M(H)$: mass of hydrogen
- $M\left({}^{A}_{Z}X\right)$: mass of X
- E_b: MeV
- $\left[Z\, M(H) + N\, m_n - M\left({}^{A}_{Z}X\right) \right]$: u

Radioactivity

Alpha

Beta

Gamma

e^-

e^+

electron capture

$N = N_0 e^{-\lambda t}$

- N: # of atoms after t time
- N_0: the initial number of atoms
- t: time
- λ: s^{-1}

$T_{1/2} = \frac{\ln 2}{\lambda}$

1000 atoms → $T_{1/2}$ → 500 → $T_{1/2}$ → 250 → $T_{1/2}$ → 125

$R_0 = \lambda N_0$

$R = \lambda N$

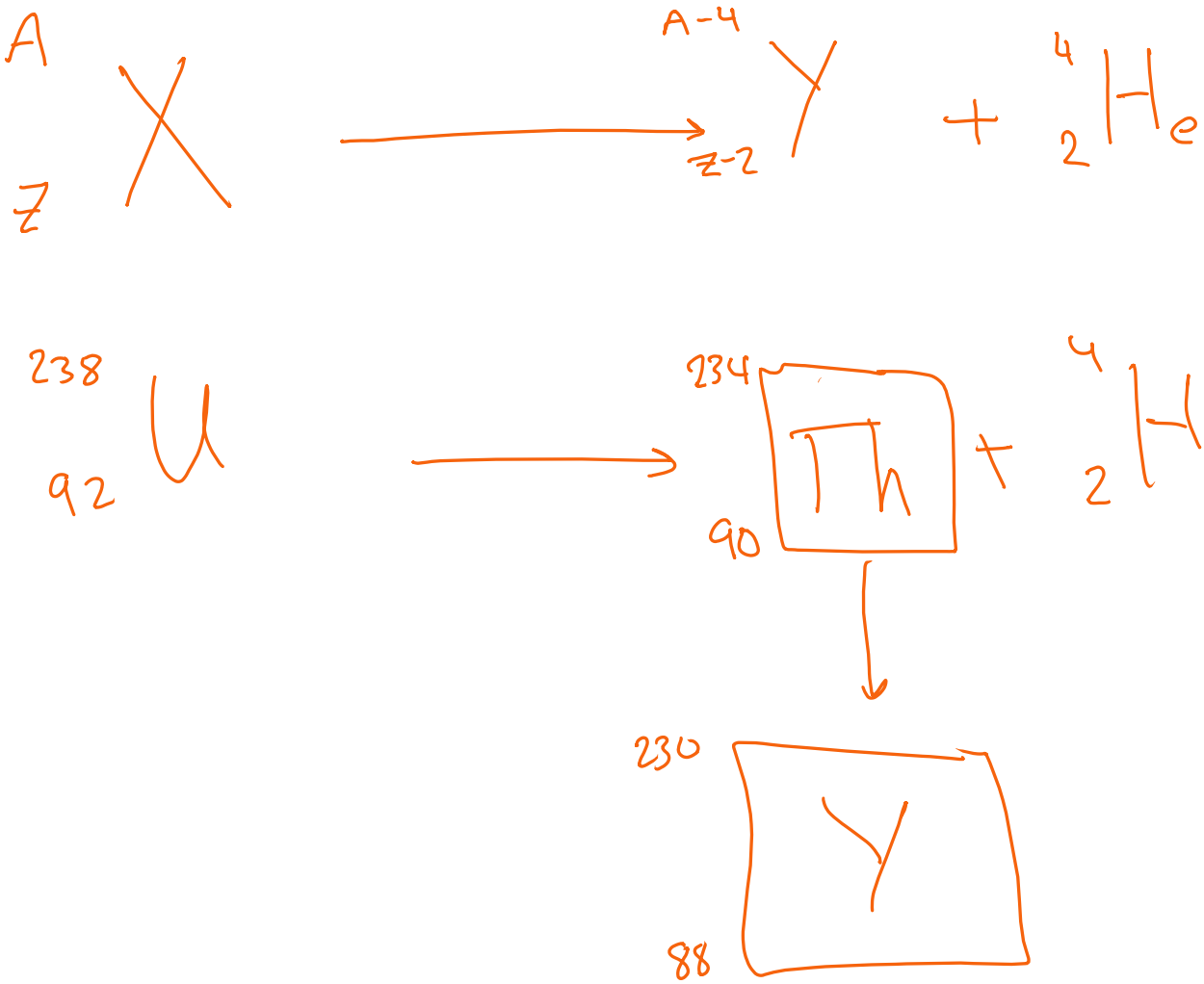
$R = R_0 e^{-\lambda t}$

- R: activity after t
- R_0: initial activity

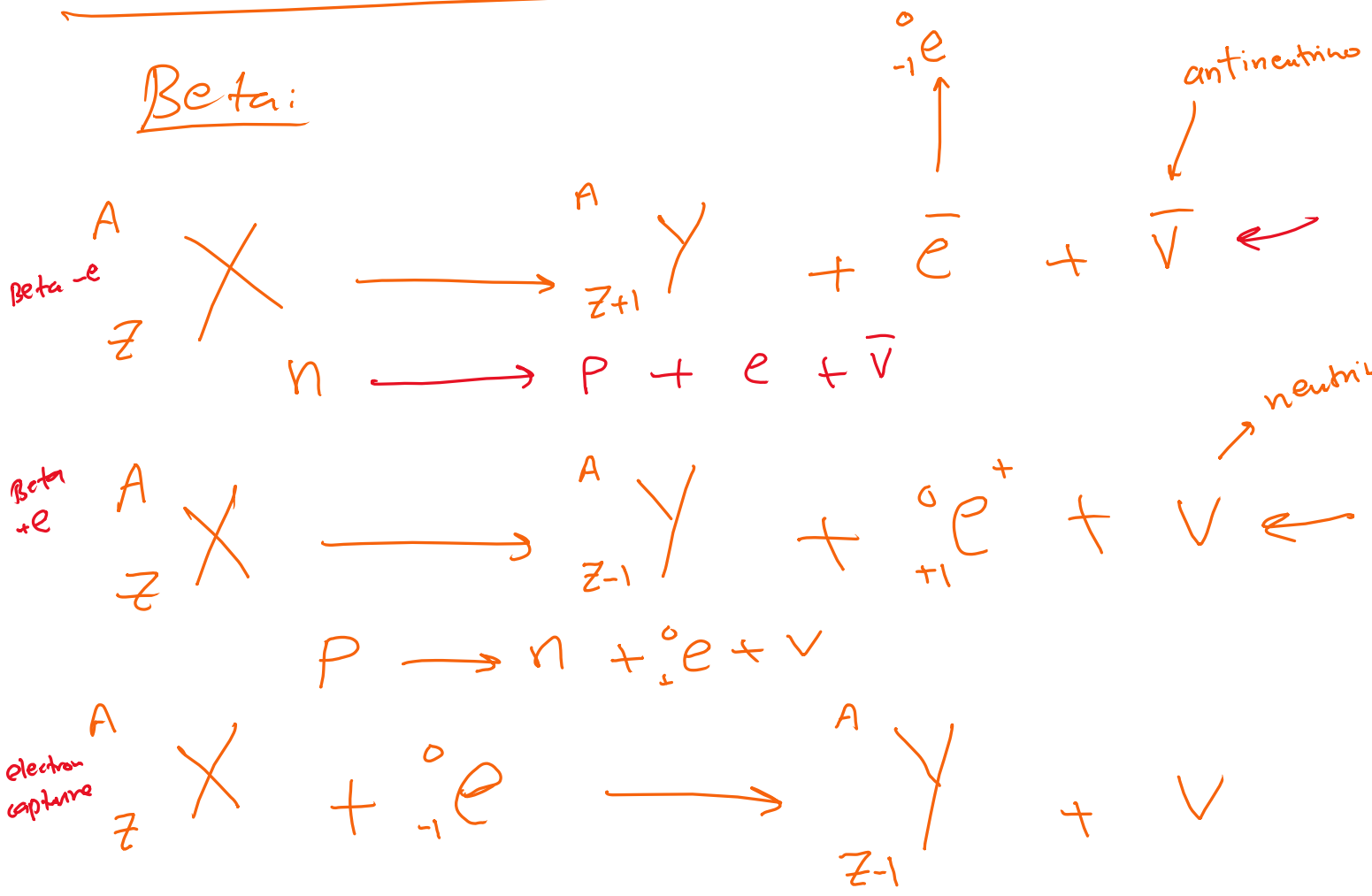
$N = N_0 \left(\frac{1}{2}\right)^n$

$R \Rightarrow$ Bq (SI) $= 3.7 \times 10^{10}$ decay/sec

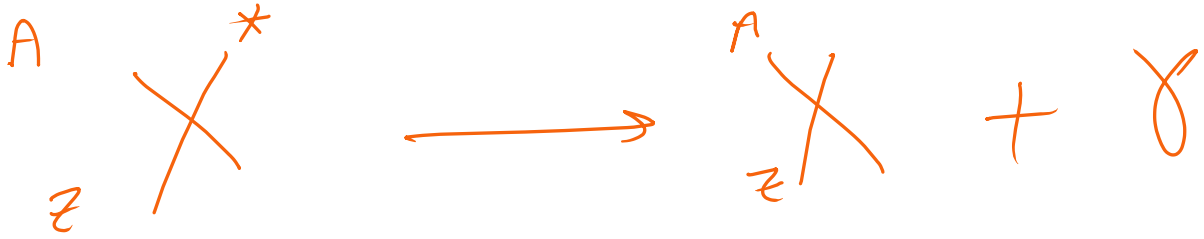
$= 1$ Ci


A
Z
X
A-4
Z-2
Y
4
2
He
238
92
U
234
90
Th
4
2
He
230
88
Y

Beta:


0
-1
e
antineutrino
Beta -e
A
Z
X
A
Z+1
Y
$\bar{e}$
$\bar{\nu}$
$n \longrightarrow p + e + \bar{\nu}$
neutrino
Beta +e
A
Z
X
A
Z-1
Y
0
+1
e^+
ν
$p \longrightarrow n + {}^0_{+1}e + \nu$
electron capture
A
Z
X
0
-1
e
A
Z-1
Y
ν

Gamma:



Disintegration Energy:

Alpha: $Q = (M_x - M_y - M_\alpha) \times 931$ (MeV) (u)

$Q > 0 \Rightarrow$ occur spontan.

$Q < 0 \Rightarrow$ cannot occur spont

Beta$^-$ $\Rightarrow$ $Q = (M_x - M_y) \times 931$

Beta$^+$ $\Rightarrow$ $Q = (M_x - M_y - 2m_e) \times 931$