Noteset 1E (Part 2)
Atomic Stability

Atomic Stability

Z-Ratio

Ratio of the # n° to # p^+ in the atomic structure.

$$Z_{ratio} = \frac{\#n^\circ}{\#p^+}$$

n° = Mass # − Atomic #

Stability and Z-Ratio

Small Atoms (1-20)
Zratio : 1 − 1.2

Medium Atoms (21-54)
Zratio : 1.2 − 1.4

Large Atoms (55-82)
Zratio : 1.4 − 1.5

Zratio > 1.5 (83+) Not Stable

Atomic Stability

$p^+ - e^-$ interactions

nucleus	orbitals
p^+ and n°	e^-

(p^+) + ← attraction — (e^-)
Full attract

(p^+) + ← n° — (e^-)
Reduced Attract shielding

Ratio too low

not enough n° (reduced shielding)

$^{11}_{6}C$: $Z_{ratio} = \frac{5}{6} = 0.83$

Ratio too high

too many n° (increased shielding)

$^{14}_{6}C$: $Z_{ratio} = \frac{8}{6} = 1.33$

Noteset 1E (Part 2)

Atomic Stability

Nuclear Stability

Atomic Size

Small : $Z_{ratio} \approx 1.0-1.1$

Medium : $Z_{ratio} \approx 1.2-1.3$

Large : $Z_{ratio} \approx 1.4-1.5$

Above Pb : Not Stable

Small $Z = 1.0$

$^{12}_{6}C$: $6p^+$ and $6n^0$

Medium $Z = 1.2$

$^{65}_{29}Cu$: $29p^+$ and $36n^0$

Large $Z = 1.5$ last stable

$^{205}_{82}Pb$: $82p^+$ and $123n^0$

Atoms above Pb

Atomic # > 82

$^{238}_{92}U$: $92p^+$ and $146n^0$

$$Z_{ratio} = \frac{146n^0}{92p^+} = 1.56$$

Above Z=1.5 Not Stable

$Z_{ratio} > 1.5$

Atom is TOO LARGE

$^{235}_{92}U$: $92p^+$ and $143n^0$

$$Z_{ratio} = \frac{143n^0}{92p^+} = 1.55$$

Above Z-ratio = 1.5 Not Stable

Noteset 1E (Part 2)
Atomic Stability

Stability of LARGE Atoms ($Z_{ratio} > 1.5$)

Alpha (α) Decay: Make atoms smaller

Alpha (α) Decay : He nucleus ($2p^+$ and $2n^\circ$)

He: e^- e^- ($2p^+ 2n^\circ$) α: empty ($2p^+ 2n^\circ$)

Result

Atom loses $2p^+$ and $2n^\circ$

$$^{238}_{92}U \xrightarrow[-2p^+]{-2n^\circ} {}^{234}_{90}Th$$

Mass# -4 Atomic# -2

Alpha Decay Equations

α decay: ^4_2He

$2p^+$ and $2n^\circ$

Decay Equation

start → ^4_2He (α) + final

Reactant yields Products

$$^{238}_{92}U \rightarrow {}^4_2He_{\alpha} + {}^{234}_{90}Th$$

238 − 4 = 234

92 − 2 = 90

Look up element

90 Th Thorium

Noteset 1E (Part 2)

Atomic Stability

Nuclear Equations

given starting isotope

Subt. Values

$^{238}_{92}U \longrightarrow {}^{4}_{2}He + \_\_\_\_^{*}$

* 238 − 4 = 234
92 − 2 = 90 Th

given final isotope

Add Values

$\_\_\_\_^{**} \longrightarrow {}^{4}_{2}He + {}^{234}_{90}Th$

** 4 + 234 = 238
2 + 90 = 92 U