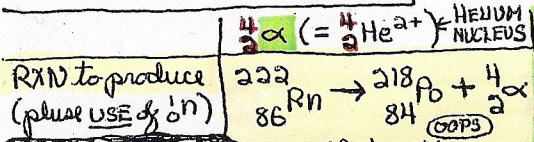


NUCLEAR RADIATION



IONIZING RADN (all: α, β, γ, n)

* β -decay with δ or without δ , both possible, we will tell you

EXAM: CHEM RXN α, β, γ, n not B!

ob. DNA $\xrightarrow{\text{HARD OH}}$ bad DNA

Ar $\xrightarrow{\alpha, \beta}$ Ar $^{+2} + e^{-}$ FREE RADICAL ELECTRIC SWITCH

PENETRATION (what SHIELDING needed to stop?)

α easily stopped by AIR (4-7"), PAPER, SKIN

so α outside body = SAFE

but α inside body = BAD, EX: lung cancers (as in ${}^{222}\text{Rn} \rightarrow \alpha$)

HEALTH EFFECTS depends on factors:

- AMOUNT of material
- $T_{1/2}$ (short \rightarrow MORE RADIACTIVE)
- outside or inside BODY
- PENETRATING / SHIELDING which depends on
- TYPE of radn (α, β, γ, n) (EX: $Q = 20$ for α)

Curie (Ci) # from SAMPLE

rem, damage to TISSUE (= of background radn)

BIO-accumulation EX: I (127 or 131) in THYROID GLAND

• Sr (mimics Ca) in BONES

• Cs (mimics Na)

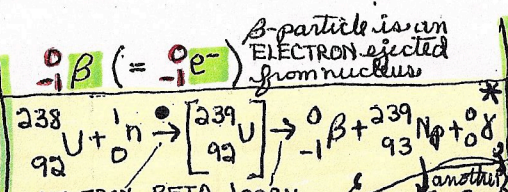
CHEMICAL toxicity (ignored in 108?)

medium long $T_{1/2}$ (see 3d in post Quiz 3 questions), 1-100y, can be physiological dangers, w/ combo of endurance + activity

2 web growth cycle of cells \rightarrow delay of radn sickness (new cells needed after 14d, but not available due to rad damage)

cancer - cells live, but in DNA-damaged form

radiation sickness - cells die



NEUTRON BETA decay

OR FISSION? β rich, neutron rich, after n -activation (${}^{238}\text{U}, {}^{107}\text{Ag}, {}^{59}\text{Co}$)

FISSION PRODUCTS (RATIO of n# / p#)

131 I vs 127 I

53 I vs 136.9 I

47 Ag vs 107.9 Ag

49 Co vs 107.9 Co

check on p 229: ${}^{90}\text{Sr}$ vs 88, ${}^{143}\text{Xe}$ vs 131 (52-89 vs 79, etc)

β in-between, stopped by Al or by a little bit of SOFT TISSUE

EX: β out of neck after ${}^{131}\text{I}$ med treatment (as in Quiz 3, 3h) 2 week GROWTH CYCLE of cells

β inside body, ${}^{131}\text{I}$ in thyroid gland, after Chernobyl, ... (thyroid cancer)

DECAY SERIES

if $n \neq p$, α and β

if $n = p$, γ

if $n = p + 2$, α

if $n = p - 1$, β^{-}

if $n = p + 1$, β^{+}

if $n = p$, γ

if $n = p + 2$, α

if $n = p - 1$, β^{-}

if $n = p + 1$, β^{+}

if $n = p$, γ

238-U decay series, because ${}^{238}\text{U}$ abundant and remains (long $T_{1/2}$), yet does decay some \rightarrow steady state w/ all isotopes that are part of decay series - all have the EVEN # (no ODD #s - why? CHAIN STOPS at Pb 82)

rapidly dividing cells: pg 303 (top), lecture w/ slide 7a)

immediately after bombs (1945) or Chernobyl (1986) ${}^{131}\text{I}$ ($T_{1/2} = 8.0$ days) was dangerous, 1 year later (or 66y, 25y) it isn't. But Sr-90 (29y) and Cs-137 (30y) are still dangerous now, due to medium-long $T_{1/2}$ (still large SAMPLE SIZE \leftarrow large $T_{1/2}$) plus HIGH RADIOACTIVITY \leftarrow (small $T_{1/2}$)

neutrons (slow, fast, thermal) DANGER, RXNS TO TISSUES

γ (\approx X-rays but α higher energy) have most penetrant ($> \beta$)

this is why γ (not β) used in GAMMA KNIFE

59 Co + $n \rightarrow$ 60 Co ($\rightarrow \gamma$)

HEALTHY TISSUE not by 2 beams, minimal damage; CANCER-TUMOR hit by many beams to kill cancer cells

ETC

VS SURGERY

REMAINS? TWO \neq DECAYED? QUESTIONS

less than 1% remains (1/2) after 7 half-lives, $T(3.8d) = 26.6d$

is it "gone"? depends on initial amount (LARGE?) + definition of GONE

3 of background radn, G-1 pg 303

Rn is 55% (by rem, w $Q = 20$)

background (not by Ci) \approx 360 Rem average

compare to find SIMILARITIES, DIFFERENCES

A = mass #

Z = atomic #

of MASSIVE NUCLEONS

of PROTONS, which \equiv the atom as U

many atoms \leftarrow high activity per atom (due to low $T_{1/2}$)

$\approx 30x$ is HIGH enough for endurance (MANY ATOMS)

but low enough for as high radioactivity per atom and this COMBINATION leads to a high Curie-rate of disintegrations/second, for the medium-long $T_{1/2}$.

FISSION RXN (\rightarrow smaller nuclei) but α, β

${}^{235}_{92}\text{U} + n \rightarrow {}^{236}_{92}\text{U} \rightarrow {}^{90}_{38}\text{Sr} + {}^{143}_{54}\text{Xe} + 3n$

2 of 3 given?

variety of fission* product combos, as in pg 303 pic, w 2 n , or 3 n

${}^{239}_{94}\text{Pu} + n \rightarrow {}^{240}_{94}\text{Pu} \rightarrow {}^{135}_{53}\text{I} + {}^{103}_{41}\text{Nb} + 3n$

\rightarrow Pu-239 produced in nuclear reactor

FIRST 3 BOMBS, 1945 (\rightarrow electricity, Pu)

July 16 (Pu, New Mex), Aug 6 (235U), Aug 9 (Pu)

* the smaller fission product ranges from 33-46% of original mass; pg 299

pg 289: chain reaction + critical mass

γ is EM radn, and (due to source) is nuclear-radn because it's produced by nuclear rxns

e^{-} has mass ≈ 0

ISOTOPES (same p# (same elmt) and diff n# (and mass#))

same chemical rxns (almost) - may have diff nuclear rxns

Fine Print (handouts), etc

learn@UW - Content (Notes and More)

SECTIONS - PAGE 108

Google Chem 108 - Craig

PURE SUBSTANCE

COMPOUND

ELEMENT

ATOMS in molecule

COA or HD...

He or Ha...

due to NIGHT 1/2

but IF sample size (# of isotope-atoms) is same, isotope w/ shorter $T_{1/2}$ will have higher Ci-rate

UNIT	* FOCUS	What is measured? "how much"?
Curie, Ci	sample	disintegrations per second
rad	tissue	energy absorbed by tissue
rem	tissue	biological damage (\equiv rads $\times Q$)

What determines "how much"?

depends on $T_{1/2}$ and sample size

$Q = 20$ for α

$Q = 1$ for β, γ